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EVALUATING A PRINCIPLED APPROACH TO THE DESIGN OF RESOURCE BASED INTERACTIVE LEARNING ENVIRONMENTS

DEFENCE ACADEMY COLLEGE OF MANAGEMENT AND TECHNOLOGY

PhD THESIS

CRANFIELD UNIVERSITY

DEFENCE ACADEMY COLLEGE OF MANAGEMENT AND TECHNOLOGY

DEPARTMENT OF FLIXIBLE LEARNING SUPPORT TEAM

PhD THESIS

Academic Year 2005-2009

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Evaluating a principled approach to the design of resource based interactive learning environments

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April 2009

This thesis is submitted in partial fulfilment of the requirements for the Degree of PhD.

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ABSTRACT

Today's technology supports the design of more and more sophisticated resource-based learning (RBL) environments. RBL is a kind of learning environment in which a set of strategies are integrated for the promotion of student-centred learning. These strategies are about how to combine specially designed learning resources, interactive media and technologies into the learning environment [108].

However, unless we provide meaningful learning content and context, the resources and other multimedia technologies are merely information resources and tools. How to design a good course is always a challenge to course designers. Principles that are based on learning theories can give courses designers a good guide. One main aim of this study is to set out a principled approach to course design for interactive multimedia learning environments. The principled approach is based on conversation theory (CT), a theory of learning and teaching. The second main aim is an evaluation of the principled approach to course design for interactive learning environments, using case studies of courses, where one or all of the principles have been applied. In the course design and learning theories literature various principles are provided. However, in general these principles have not been fully evaluated. The evaluation study reported here is thus a major contribution to the field. A third aim is to exemplify and evaluate a knowledge and task analysis based approach to generate adaptive teaching for helping students learn the required knowledge correctly and efficiently.

The research processes of this study were: (1) to build a conceptual framework for CT and interactive learning environments through a literature review; (2) to describe the course design principles and how they are applied in course design;(3) to evaluate the effectiveness of the principled course design model with two case studies (4) to use a knowledge and task analysis based approach to generate adaptive teaching for helping students learn the required knowledge correctly and efficiently and adaptive teaching with one case study; and (5) to present the conclusions and future areas of research.

ACKNOWLEDGEMENTS

I would like to thank my research supervisor, Dr. Bernard Scott, who has spent time and effort helping me complete my research. Through numerous meetings with him, I learnt new aspects in doing academic work and also how to be a PhD student. I also want to thank him for enduring and revising my poor writing. Without his patience and guidance, I could not have completed the research and made up my mind for a future academic career.

I want to express my gratitude to Dr. John Pryce and Dr. Ian Owens, who are my committee members. They have provided valuable comments and insightful suggestions for my research.

I would acknowledge the support from Aurélie Owens, Jane McDougall, Katie Janota, Nigel Donald and Piers Maclean. Were it not for their supports, the complementation of my research would not have been easy. I have spent so much enjoyable time with them. Further, I want to thank all the respondents who have joined the experimental studies of the research.

Last but not least, I would like to give my special thanks to my dear family, my husband John and my lovely daughter Conghui, who have given me their love and support throughout.

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GLOSSARY

AEH: Adaptive Educational Hypermedia

AH: Adaptive Hypermedia

AHS: Adaptive Hypermedia System

AICC: The Aviation Industry CBT (Computer-Based Training) committee

ANOVA: Analysis of Variance

ANS: Adaptive Navigation Support

AST: Adaptive WWW-Courseware for Statistics

Bb: Blackboard

BOSS: Belief and Opinion Sampling System

CASTE: Course Assembly System and Tutorial Environment

CCDMs: Constructivist Course Design Models

CMC: Computer-mediated communication

CMS: Content Manage System

CMLEA: California Media and Library Educators Association

CT: Conversation Theory

CTCDM: Conversation Theory Course Design Model

DBMS: Database Management System

DAEP: Defence Academy e-learning platform

ICSC (L): Initial Command and Staff Course (Land)

INTZA: An Intelligent Tutor System for Industrial Environments

ITS: Intelligent Tutoring Systems

ISTAR: Intelligence, Surveillance, Target Acquisition, and Reconnaissance

JOTAC: Junior Officer Tactics Course

KTABAE: Knowledge and Task Analysis Based Adaptive Environment

KTALBSC: Knowledge and Task Analysis Based Adaptive Teaching Sequences Construction

NCODE: National Council of Open and Distance Education

LA : Lesson Assessment

LMS: Learning Management Systems

Metadoc: An adaptive hypertext reading system

MK: Military Knowledge

MMP: Modular Masters Programme

OCDMs: Objectivist Course Design Models

OCD: Officer Career Development

RBL: Resource Based Learning

QA: Quality Assurance

Qmark : QuestionMark

RMAS: Royal Military Academy at Sandhurst.

SAQs: Self-Assessment Questions

SCORM: Sharable Courseware Objects Reference Model

SME: Subject Matter Expert

VLE: Virtual learning environment

WebPVT: Web Passive Voice Tutor

1 INTRODUCTION

As is well known, the fundamental aim of education is to offer high-quality teaching and learning opportunities to students. Thus technological possibilities offered by resource based learning (RBL) should not be allowed to obscure this aim. For example, if we develop a web-based RBL environment, we cannot just put a course online and expect the course to be successful; it must be carefully and appropriately designed. Furthermore, some web course management systems are widely used. For example, WebCT, Blackboard and Moodle are some of the systems presently used. Though they provide good quality management for course, they have little support for effective course design.

This thesis investigates Conversation Theory (CT) and of its use for course design and the design of RBL environments. It includes an investigation of current learning theories and approaches to course design, with a view to synthesising them and proposing a principled approach to facilitate the effective use of RBL. The approach is based on CT as developed by Pask and colleagues [118]. The approach is intended to be relevant and applicable to a variety of learning environments, such as instructional resources and products, interactive learning environments, flexible learning environments, web-based learning, independent study and open-ended learning experiences that are generally termed 'RBL'.

1.1 Research aims

One main aim of this study is to set out a principled approach to course design for interactive multimedia learning, environments. The principled approach is based on CT, a theory of learning and teaching.

The second main aim is an evaluation of the principled approach to course design for interactive learning environments, using two case studies of courses, where one or all of the principles have been applied. In the course design and learning theories literature various principles are provided. However, in general these principles have not been fully evaluated. The evaluation study reported here is thus a major contribution to the field.

Traditional "static" RBL applications have one big limitation in that the same content was provided to all users. For example, the same explanation and the same next page will be presented to all students, even though they may have widely different learning goals and knowledge of the subject.

From this perspective, interactive RBL is an alternative to the traditional "one-size-fits-all" approach in the development of RBL. Individual differences would affect knowledge comprehension, strategies and performance [91]. Therefore, a flexible instructional setting which adapts to different learners is necessary. This referred to as "adaptive teaching". Well-designed adaptive teaching not only adapts to learner's individual difference, but also permits students to achieve mastery of the tasks

undertaken [71]. Its goal is to train the ability of independent and active learning [5]. CT was used by Pask and Scott as a basis for the design of adaptive teaching, a feature absent in the two main case studies.

A third aim is to exemplify and evaluate a knowledge and task analysis based approach to generate adaptive teaching for helping students learn the required knowledge correctly and efficiently. Accordingly, a third case study was carried out to exemplify and evaluate the CT approach to adaptive teaching. The knowledge and task analysis-based approach of CT is used to model students' progress and an algorithm, the Knowledge and Task Analysis-Based Adaptive Teaching Sequences Construction (KTABATSC), is proposed. This algorithm can generate adaptive teaching sequences for helping students learn the required knowledge correctly and efficiently and also to overcome encountered problems. Based on this algorithm, an adaptive teaching environment was developed and evaluated. In this research, it is called a Knowledge and Task Analysis Based Adaptive Environment (KTABAE).

The third case study took the form of an experimental investigation comparing adaptive and non-adaptive lessons as the main independent variable. The research design included a second independent variable, the use or not of Lesson Maps to aid navigation. Based on earlier work on individual differences, it was hypothesised that some learners at least would benefit from the use of a Lesson Map to provide them with a holistic picture of course content and a means to navigate in a non-linear between lesson topics.

To summarise, the research processes of this study were: (1) to identify leaning theories through a literature review; (2) to specify a principled course design model; (3) to propose the adaptive rules to generate adaptive teaching sequences for helping students learn the required knowledge correctly and efficiently; (4) to evaluate the effectiveness of the principled course design model by conducting two case studies of online Military Knowledge (MK) coursed and Online Master's Programmes at Cranfield Defence and Security; (5) to design and develop an adaptive teaching lesson; (6) to analyse the effectiveness of this adaptive lesson; (7) to evaluate the usefulness of the provision of a Lesson Map.

This chapter presents research aims, research values, research questions and research methods. All of these are presented in the following sections.

1.2 Value of the research

There is a large amount of literature on current learning and course design theories, which can be overwhelming for designers and practitioners of RBL. The condensed and integrated framework for course design and learning theory generated in this study, and named the CT course design model offers a utility to course designers. It proposes a specific development model or design process. This serves as an aid in the design, development and delivery of RBL environments.

The inherent value of the study is the evaluation of the effectiveness of the principled approach to course design. This is investigated in two case studies .The studies

contribute to an understanding of CT and informed practice of course design, development and delivery of RBL environments.

The other important contribution of the research is the exploration of the use of adaptive teaching in RBL. CT provides the Knowledge and Task Analysis methodology to help achieve this aim. A pilot adaptive lesson has been developed and evaluated in order to establish guidance for the use of adaptive teaching methods in RBL for teachers and researchers.

1.3 Statements of research questions

In order to achieve the aims as described previously, two case studies were designed to evaluate the course design based on CT. These were the Military Knowledge (MK) and Online Master's Programmes at Cranfield Defence and Security. The differences between these two case studies are that MK fully used the principled approach to course design, whereas the Online Master Programmes only partially used the principled approach. A third research study was about the investigation of adaptive teaching. The CT knowledge and task analysis methodology was used to develop one of the MK lessons in an adaptive format. A summative test and q questionnaire survey were employed to investigate the effects on students' learning performance and their attitudes towards adaptive teaching.

The researcher attempted to get the answers from these three case studies through exploring the following research questions.

a. Are students satisfied with this kind of course design?
b. What are students' perceptions of the features of the course design:
    (1) learning outcomes
    (2) Knowledge Map and Lesson Maps
    (3) Learning designs using activities
    (4) Lesson assessments
    (5) Summaries
c. What variables affected the perspectives of the students on the courses?
d. How do students respond to and interact with the courses?
e. Would the interaction of lesson map assisted learning and adaptive teaching be significant in the learning performance?
f. Would the performance of the lesson map assisted learning group be better than no lesson map assisted learning group?
g. Would the performance of the adaptive teaching groups be better than the non adaptive teaching sequence groups?
h. Would the interaction of lesson map and adaptive teaching be significant in student's attitudes toward the design of the instruction?

1.4 Research methods

Once the research aims and research questions of a study are in place, appropriate research methods can be selected to address the nature and requirements of the problems. Reeves [127] present six major types of research methods used by educational technologists:

- General Research Methods for Educational Technology
  - Quantitative - experimental, quasi-experimental, correlation and other methods primarily involving collection and statistical analysis of quantitative data.
  - Qualitative - observation, case studies, interviews, etc. involving the collection of qualitative data and its ethnographical analysis.
  - Critical theory - deconstruction of texts, technologies, or systems, to reveal hidden agendas, disenfranchisement, etc.
  - Historical - objective and accurate reconstructions of the past, frequently with the aim of substantiating a hypothesis.
  - Literature review - various forms of research synthesis, primarily involving analysis and integration of other forms of research, for example, meta-analyses.
  - Mixed-methods - approaches that combine a mixture of research methods - usually quantitative and qualitative - in order to triangulate findings.
- Research methods used in this study

The research methods used in this study involve several of the above. There was a literature review with the goal of exploration, analysis, integration, and synthesis within the broad field of RBL, learning theories, course design and interactive teaching. Following there were case study evaluations, which combined qualitative and quantitative research methods.

- Literature review

In order to have a comprehensive understanding of RBL, course design and interactive teaching numerous sources were used. This literature was taken from three sources comprising of journals, books and the Internet. After reading the data, they were categorised into three parts which were RBL-related, course design related and interactive teaching related. Using this approach, it was helpful to understand the basic concepts of the different research questions.

- Survey

In order to know the general effects of course design and adaptive teaching, surveys were conducted. Descriptive statistics were used to analyse data from the surveys.

- Interview

The purpose of the interviews in this study was to know more about students' perceptions of aspects of course design. The method of analysing what was gained from an interview was by transcribing the audio recording of the interview. Then, all of the answers from the transcript were categorised into several categories by influential factors which form the results of survey. And then each category was analysed further.

- Observation study

In order to know how students interacted with the courses designed by the principled approach to course design, observation studies were employed.

- Summative test

In order to investigate the effects of lesson map and adaptive teaching on students' learning performance, the present study used the four different types of instruction and a summative assessment test.

1.5 Research procedure

According to the above four sections, the procedure of this research can be organised as follows: (Figure 1.1)

a. To identify the research topic and purposes

   The extent of RBL is very wide. There are many issues in this field and in order to identify various topics, a review of many journals and books is necessary. The topic of this study was generated after reading many sources. At the same time as the purposes of this research were identified, it was also a chance to find out the reasons why the researcher wanted to be engaged in this study.

b. To review related literature

   In order to generalise the course design from first principles and adaptive teaching, a substantial amount of related literature was reviewed. Predecessors' research, journals and books that are related to RBL, course design, adaptive teaching and research methods were included in the part of the related literature.

c. To establish the framework to write a proposal

   After reviewing literature, a basic framework was formed to write a proposal. The framework consists of several parts included in this research study. These

are literature review (RBL, course design, and adaptive teaching), research methods (qualitative and quantitative research methods) and three case studies.

d. To develop the three case studies

When the proposal was completed, the three cases which comprised of MK courses, MMP courses and adaptive teaching RBL were studied.

e. To observe students study for one of the case studies.

f. To develop questionnaires for the first two case studies and to design an instructional experiment for the third case study.

The first instrument was questionnaires for three of the case studies. Items of the questionnaire are generated based on the part of literature review. And the summative assessment tests are for the third case to compare differences between adaptive teaching and normal teaching.

g. To examine and revise

In order to make the questionnaires more valid, experts' examination is very important. At this step, the proposal and questionnaires were examined by members of the researcher's thesis committee and by members of the DA-CMT Flexible Learning Support Centre. Revisions were made based on their professional suggestions.

h. To sample

Samples were divided into three groups in the first case study of the MK course. Group 1 was used for the survey, group 2 was used for the interviews and group 3 was used for the observation studies. The second case study of the online master courses were sampled with the agreement of the course tutors. In the third case study of adaptive teaching, the same group was used for the assessment test and survey.

i. To survey via a survey website

Two different questionnaires were developed for delivery by a survey website. The website links to the questionnaire were sent to the military officers who were identified in group1 of the MK case study and to the online master programme students.

j. To develop interview questions

Questions for the interview were based on the result of from the MK survey.

k. To interview and collect data

Interviews can help us to understand about people's experiences and opinions in more depth. In this step, it helped us to understand in more depth whether course design from first principles and adaptive teaching had an influence on the satisfaction of students.

l. To analyse data

After interviewing, the record responses were transcribed. These were analysed by categorizing each of the paragraphs or answers into subcategories to find out which factors had an influence on students satisfaction on course design.

m. To discuss the findings

After analysing data from the observational study, surveys, interviews and knowledge tests, the finding from the three case studies were discussed. Some other findings are also mentioned.

n. To draw conclusions and suggestions

Not only are findings reviewed here, but also are some of the limitations, other problems and suggestions etc.

o. To write a thesis

All of these findings and results are written down as a thesis.

p. Finish

After completing the thesis, this study is finished.

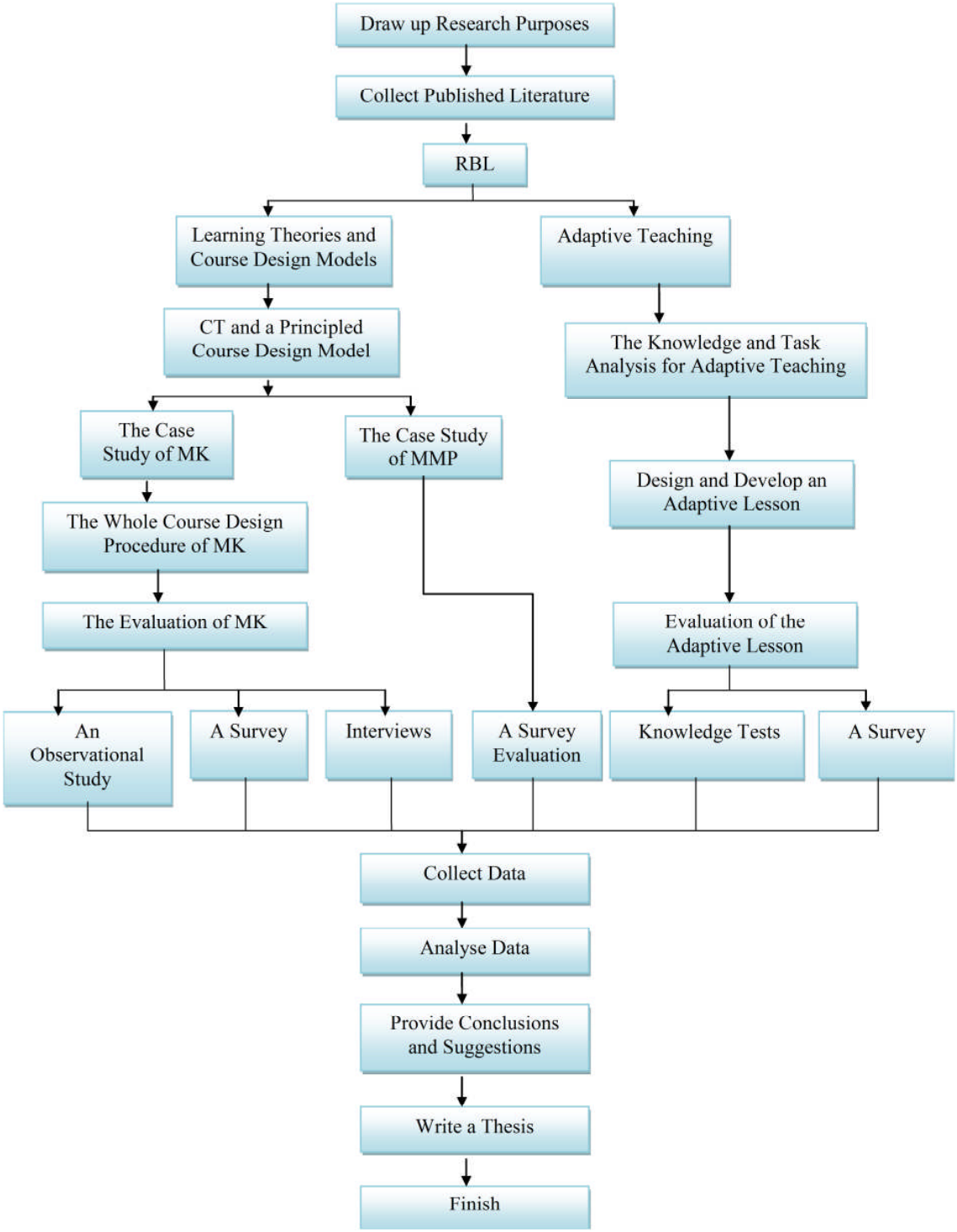


Figure 1.1 : Research Procedure

1.6 Structure and chapters of this thesis

Chapter One: Introduction
Chapter one introduces the study - its research aims, research value, research questions, methods and overall research procedure.

Part 1: Resource based learning.
This part is one chapter (Chapter Two). In this chapter, the research took a deep review of RBL—studying the definitions of RBL, the dimensions of RBL, the advantages and disadvantages and the important issues of RBL.

Part 2: Course design of RBL
This part includes four chapters (Chapter Three, Four, Five and Six).
In Chapter Three the researcher undertook an extensive overview of theory studying philosophies and paradigms of learning and course design models – proposing CT and a principled course design model which is more suitable for the course design of RBL.

Chapter four describes how the course design was applied in the MK (Military Knowledge) courses.

Chapter Five and Six describes how the evaluations were conducted in two case studies of MK and the online master programme which were designed and implemented based on the first principles and the whole course design model.

Part 3: Adaptive teaching
Intelligent tutoring systems, adaptive hypermedia, knowledge and task based adaptive teaching systems.

This part covered the same ground as part 1 and part 2, but from an implementation of interactive teaching perspective – reviewing interactive teaching within RBL environments and proposing an adaptive teaching system for effective interactive teaching.

There are four chapters in this part. Chapter seven and eight are about intelligent tutoring systems and adaptive hypermedia. These were the basic literature background for adaptive teaching. Chapter nine proposes a knowledge and task based adaptive RBL environment which was based on the last two chapters' review. It also describes how this adaptive teaching environment was designed and implemented. An evaluation of this adaptive case lesson is made in Chapter ten.

Chapter eleven presents the conclusions of the whole thesis.

PART 1 RESOURCE BASED LEARNING

In this part, a deep review of RBL is taken in order to have a good understanding of how to do the course design of RBL.

2 WHAT IS RBL?

RBL is a fairly new trend in teaching and learning. It emerged as a commonly used term in the early 1990s[63]. A well designed RBL course can aid both teaching and learning. Before a RBL course is designed and developed, designers and developers should have a full understanding about RBL. In this chapter, RBL is explored in more depth, including its definitions, advantages, disadvantages, along with the important issues in RBL.

2.1 The definitions of RBL

Many experts have defined RBL. Broadly, using different resources to deliver learning and learning environments could be called RBL [138]. Table 2.1 below states the definitions of RBL defined by different researchers or units. The researcher decided to adopt the definition of NOCDE[108] in this study.

Table 2.1: Definitions of RBL

Researcher/ Unit	Definitions
NCODE [108]	RBL is "an integrated set of strategies to promote student-centred learning in a mass education context, through a combination of special designed learning resources and interactive media and technologies".
Gibbs et al [63]	RBL can be described as the following: "enhancements to conventional courses; lecture substitutes; distance learning on campus; self-contained 'tutorials in print'; self-pacing; alternatives to the lecture environment which allow the student to progress at his or her own pace; substitutes for specific learning activities e.g. computer simulations of experiments; Support for learning activities, e.g. study guides, field guides etc; and hybrids, i.e. systems which emphasise class contact and learning resources in varying degrees".
Khan[89]	"A resource-based instructional environment which utilizes a variety of resources to create a meaningful learning environment where learning is fostered and supported".
Darwinmag [41]	"Interactive learning that uses computer and communications technologies to train or educate; but instead of replacing a teacher with a computer, technology is woven into all aspects of the educational process, including its design, delivery, testing and application".

Though the above definitions are not identical, there are two common themes: one is the central role is learners rather than a human teacher in RBL, the other is a variety of resources that are integrated within teaching and learning, especially modern information technology, such as the Internet.

In addition, Scott [138] notes a good way to understand what RBL is. He states that it is to contrast it with what is not RBL. So what is not RBL? This is "where the main resource is a human teacher who delivers lessons, lectures and seminars to groups of students, from as few as one or two, to as many as two to three hundred at a time". In traditional learning environments, the role of the teacher is essential. Scott[138] has described the role of the human teacher in a traditional learning environment as a person who is expected to have responsibility for student progress.

From this point of view, Scott emphasize that "RBL is about the modification of the central role of the human teacher"[138]. According to CMLEA (California Media and Library Educators Association) , compared with traditional learning environments, "the learners with RBL take responsibility for selecting resources, human or otherwise, that appeal to their own learning preferences, interests and abilities"[33]. Some other terms such as 'self-access,' 'independent learning,' 'open,' 'distance,' and 'flexible' learning have often been used to describe similar activities in which the teacher has more or less input into what goes on in the classroom. (The bottom line in all these uses is that teachers are encouraged to turn some responsibility over to the learners and simultaneously take on such roles as bystander, facilitator, guide, or helper.)

Another important character of RBL is that it requires course designers and developers to exploit a variety of learning resources to design, deliver and manage the courses. In a conventionally designed course, the main resources are print-based materials that are not flexible to support student learning. In RBL, the learning resources may not only be printed materials, but may also be electronically-based materials. Arguably, if well-designed, these varied resources can support learning more efficiently and effectively than traditionally designed courses.

2.2 The dimensions of RBL

RBL, however, has progressed to have a broader set of strategies or dimensions, which means that a RBL environment might combine one or more of the dimensions [144] . To conclude, there are five dimensions, which are shown below.

- Offline vs. online learning

To summarise, a RBL environment like this usually stands for online learning over the Intranet or Internet and offline learning in a traditional classroom setting. One of the examples of this type of environment may provide materials and resources over the Web, while offering instructor-led learning in the classroom as the main instruction.

- Self-paced vs. live and collaborative learning

Self paced learning represents the learner having the control over the learning. Literally, collaborative learning implies many sharing knowledge among many learners.

- Structured vs. unstructured learning

Structured learning stands for a formal learning environment with order like chapters in a textbook. However, most learning in the work place usually appears in an unstructured way, such as meetings, memos, e-mails, and so on. Therefore, a blended environment such as this may mix the conversations or documents from unstructured learning with the knowledge repositories available.

- Customized content vs. off-the-shelf content

Off-the-shelf content could be the organisation's exclusive context and requirements, which are a lot less expensive than custom content. A RBL environment like this will not only enhance the learner's experience but can save costs for the organisation as well.

- Learning practice vs. performance support

The best form of RBL is to extend learning with practice and just-in-time performance support tools facilitating the appropriate execution of job-tasks.

2.3 Advantages and disadvantages of RBL

Although "RBL" is a new term, the concept has existed for some time [144; 145]. It is derived from the idea that learning is a continuous process, instead of a temporary event. RBL provides a variety of benefits.

- Better learning effectiveness

RBL with a good course design actually improves learning outcomes. Moreover, it can meet the learning needs of different people as they have their own way to learn. RBL has the potential to have meaningful and renewable contact with learners over time. RBL makes it easy to give learners pre-work, course-work, and reminders with possibly less cost and difficulty [149] .

- Extending the reach

RBL can be more flexible because it mixes two or more resources together. For instance, a single traditional classroom may not be suitable for people on the move with inflexible timetables. Virtual classrooms can solve this problem.

- Lower cost

Developing complete e-learning may be too expensive. However, combining it with other documents or resources may lower costs, so RBL can be as effective or even possibly more effective.

We can conclude that there are benefits of RBL but as with all learning environments there can be some drawbacks also. For students these drawbacks could be working alone and also having no direct interaction between the teacher and the learner could be a factor. Thus, students may fall behind if they are low motivated. They may get lost or confused about course activities. They may feel isolated. The teacher may not always be available when needed. They may feel frustrated if the connections to the Internet are slow. It can be difficult to do practical work in RBL environments. For teachers, how to establish a communications link between them and learners is a challenge. They need to learn new ways to give feedback to students [112]. In addition, it could be labour intensive to create the course content or update someone else's material.

Though there are disadvantages of RBL, it is still an inevitable trend because of its advantages. Arguably if course designers know what are the important issues relating to RBL and the design of a good RBL course then those disadvantages can be decreased or even eliminated.

2.4 Important issues relating to RBL

This section looks at the important issues related to the teaching and learning of RBL in order to have a good understanding of the design of RBL. These issues are: (i) the roles of learner and teacher, (ii) design and (iii) quality of RBL.

- The Role of the RBL Learner

As we mentioned before, one important characteristics of RBL is that the role of the learners is central. It also means learners need to be more independent, compared with the learners in traditional learning environments. They need to take responsibility of their own learning.

Often students enter an RBL course carrying the same expectations as they would with an 'on-campus' course that is taught in a classroom environment, i.e. that the teaching staff will 'teach' and they will 'learn' from the material provided [115].However, the roles students need to take on in a RBL environment are much different from those in the traditional classroom-learning environment. Palloff and Pratt [115] suggest that "What distinguishes RBL from traditional classroom learning is that students need to take responsibility for their learning". Specifically they identify three different roles that a RBL student needs to take on: knowledge generation, collaboration and process management [115]. Laurillard [99] also suggests that "computer-based learning has a major role in promoting self-directed learning and increased student autonomy". Obviously, RBL learners are perceived to possess unique characteristics that make them independent, self-efficient, and willing to take the risk and responsibility of relying more on themselves than on others.

However, we cannot assume students know how to take on these roles automatically. They need to be told what is expected of them when they enrol in a RBL course or even to be taught about how to take on these roles [115]. Thus, a well-designed course needs to support students in becoming more efficient and effective independent learners.

- The Role of the RBL Teacher

The literature suggests that there is a change of role for teachers in the RBL environment. Many have described RBL teachers as knowledge facilitators [75;36] and managers of learning[1].

With increasing amounts of information on all topics being published and accessed on the different resources, people no longer 'own' knowledge. If you know something, it is likely that others know the same. Therefore, in RBL teaching environments, one does not 'teach' in the same way as one does in the classroom. Rather, what is called for is a process of guiding and assisting whenever students are in need. The key issue is how an educator could help students to gain that knowledge and to make meaning of that knowledge. As Oliver [111] pointed out, the role of the RBL teacher is "no longer the sage on the stage" but more of a guide or a coach who provides the students with access to a variety of independent learning experiences. Teachers are expected to change the ways in which they organise and deliver teaching material [115].

Therefore, in RBL teaching environments, one does not 'teach' in the same way as one does in the classroom. Teachers are expected to change the ways in which they organise and deliver teaching material [115]. Alexander [3] also argues that "educational developers should make use of the knowledge of learning together with an understanding of the features of resources, to design learning experiences which promote a deep approach to learning so that 'what' students learn is a deep understanding of the subject content, the ability to analyse and synthesise data and information, and the development of creative thinking and good communication skills".

- Design

There have long been debates on which is the most appropriate approach in teaching and learning. How to design a good course for students in RBL?

Wilson and Lowry [158] argue that people use the different resources all the time for self-directed purposes and through searching information, one is constantly constructing meaning. Often the different resources, as a whole, are unedited, un-refereed and always changing. They provide information from many different sources, often from different perspectives. Users have to learn quickly to judge the quality of conflicting sources [158]. To achieve this, we need to provide students with a well designed learning environment to help them interpret and evaluate information [158].

The design of learning materials has been guided by principles of course design, where the aim of the material is to provide a means to "transfer knowledge from the minds of the expert (teachers) into the minds of the learners" [111]. As the course developer, not only does the academic have to ensure the content of the course is appropriate but he must also ensure that the material is taught in such a way that the learning outcomes are being achieved.

Interactivity is another key consideration when designing RBL material [138]. The effect of interaction is also well supported by education theory, as Barker [9] puts it "interaction is a necessary and fundamental mechanism for knowledge acquisition". With the aid of technology, Lander [96] argues that "the effects of interactions between the learner and the tasks at a cognitive level can, in many cases, be richer and more effective in RBL than face-to-face situations". Feedback given to students from instructors forms an important part of interactivity in a RBL environment. Dringus [49] suggests that three types of feedback: immediate feedback such as comments on assignment work; automated feedback such as scheduled system maintenance or policies; and personal feedback such as praise or critique on individual progress. They could enable learners to remain focused on learning and communicating in an RBL environment.

- Quality of RBL Courses

Quality has always been an important issue as far as formal education is concerned. The use of technology such as the Internet for RBL course delivery has provided much greater education accessibility and flexibility to many learners. It has, however, also created new challenges for quality assurance and accreditation. There is one basic perspective to assess the quality in RBL: student satisfaction [102].

Student satisfaction is an important measure of quality. The literature has various suggestions on how student satisfaction could be achieved. Moore[102] stressed that students, like customers, are satisfied when they received responsive, timely, and personalised services and support, along with high quality learning outcomes. This "consumer-based" means of judging quality is very much in agreement with Pond's [126] view that the emphasis should be on student experience rather than institutional experience and those students play an important role in determining quality in education. Pond also suggests that an "outcome based" model could be used in assessing quality in education where one should "focus on what outcomes we desire from educational experiences, not the means by which they are delivered" [126].

PART 2 COURSE DESIGN FOR RBL

In this part, an extensive review of theory is undertaken, which includes studying philosophies, paradigms of learning and course design models. Then CT and a principled course design model are proposed, which is suitable for course design for RBL, compared with other learning theories and course design models. There is then a description of how this course design was applied in developing the MK courses. At the end of this part, two case studies described how the evaluations of the course design model were conducted.

3 HISTORY OF LEARNING THEORIES IN COURSE DESIGNS AND MODELS

How to design a good RBL environment which can promote learning of the independent learner? Although there are varieties of learning resources that can be used in RBL, Rovai [133] argues that "They are just the delivery medium and they cannot be the determining factor in the quality of learning; rather, the design of the course determines the effectiveness of the learning".

Meanwhile there are many course design models which are based on different learning theories that can be used. Before we design and develop any course, we should know the principles of learning and how students learn and what is learning tacitly or explicitly. Once this is determined we can choose a suitable course design model according to the learning theory. This is especially important for RBL, since the role of teacher and the student are different from those with traditional learning environments. Proven and sound learning theories should be the base of the design and development of effective RBL courses.

In citing various learning theories, Vargo [151] further pointed out that "Effective learning is not just about the efficient transfer of certain quantities of knowledge, but it is also about developing skills and attitudes for life-long learning, it is about experiencing the joy of learning, it is about both factual knowledge and developing good judgement." In addition, as described before, the roles of learner in RBL are independent and self-sufficient. Sound learning theories can be used to design a good RBL course which can let students take the roles. There are many learning theories to explain what is learning. At present, it can seem somewhat confusing to sort out the various learning theories and associated course design strategies.

Thus, the aims of this chapter are:

- Provide an overview of prominent traditional and current learning theories.
- Discuss Conversation Theory as the main theory behind RBL environments.
- Reviewing commonly used course models and principles.

- Identify a course design model that can be used for RBL.

This chapter first compares the four underlying philosophical views of knowledge and learning, aimed at identifying the theoretical position(s) of learning theories relevant for designing an RBL course. Then, commonly used course design models and principles are reviewed. The purpose is to identify a learning theory and a course design model that can be used for designing the overall RBL course.

3.1 The conceptual learning theories for learning environments

To identify a particular learning theory or theories that can be used for designing a RBL course, this study reviewed four main learning theories: Behaviourism, Cognitivism, Constructivism and Conversation Theory.

3.1.1 Behaviourist approach to learning

What is Behaviourism? A behaviourist's approach to understanding learning maintains that learning occurs when a proper response is demonstrated by the learner who is presented with a specific environmental stimulus. Therefore, according to Good and Brophy [65], "Behaviourism places an emphasis on overt behaviours that can be observed and measured quantitatively." Behaviourists think of both learner characteristics and environmental factors as important elements for learning to occur. As Driscoll [50] notes that "The most critical factor is the arrangement of stimuli – response – reinforcement." The role of memory in learning is not a concern in Behaviourism, in which forgetting means that a response has not been demonstrated over time. Behaviourists believe that transfer of learning is facilitated in situations involving identical or similar features to which the learner can generalize learning experiences [54].

Contributions of Behaviourism to Instruction: A Behaviourists approach to learning is said to be effective for learning types in which the learner is required to recall facts, to define and illustrate concepts, to apply explanation, and to automatically perform a specified procedure.

The key characteristics of behaviourism are the systematic design of a course. Systematic design procedures became inherently behaviourist as practices derived from systems theory were used to make instruction more effective, efficient and relevant [25;24] . It achieved this by designing outcomes, content, instructional methods, and learner-assessment procedures in congruence with one another, as indicated in Table 3.1.

Table 3.1: Tightly coupled approach to elements of instruction

Instructional objectives	Content of instruction	Assessment procedures
A set of observable, measurable objectives is defined early in the design process.	Instruction is focused on leading learners to achieve those objectives. Methods and instructional strategies are used which are appropriate for the objectives.	The objectives are used to create corresponding test items for learner-evaluation. Assessment is frequently developed prior to designing the actual

		instruction.

Challenges in RBL: Some challenges are expected when behaviourist approaches to learning are applied to a RBL environment. For example, behaviourists state that learning takes place through the arrangement of stimulus– response–reinforcement [54]. This also means that learning should not occur if there is no stimulus for the correct response. However, human beings do not initiate all behaviours that have been reinforced. They also tend to demonstrate new behaviours without any reinforcement [50].

Behaviourism also minimizes the role of thought in the mind by totally ignoring the possibility of mental processes occurring in the mind. However, one of the main features that the RBL environment seeks is to teach students to actively pull together many different resources with modern technology. In order to do that, students are required to think creatively, analyze, and solve the problems in different ways.

Furthermore, Behaviourism emphasizes the design of instruction and the imparting of knowledge, with the goal of achieving effective and efficient learning which is demonstrated by behavioural changes. The role of the instructor is paramount over the role of the learner, who tends to receive instruction in a passive manner. The processes are geared towards learners in general, and are not focused on individual learners.

3.1.2 Cognitive approach to theory

What is Cognitivism? Cognitivism is a cognitive learning approach to understanding learning, which views the human learner as an information processor [50;54] . Ertmer & Newby [54] describe knowledge acquisition as "a mental activity that entails internal coding and structuring by the learner" (p. 58). The factors that influence learning include the ones that affect the learner's mental activities, such as his/her attention to environmental stimuli and information retrieval. To guide learning, therefore, various methods such as demonstrations, corrective feedback, instructional explanations, and illustrative examples are considered.

Unlike Behaviourism, cognitive learning considers that memory is important in the learning process. It views forgetting as the memory not having the ability to retrieve information due to memory loss or interference. To help the learner link new information to existing knowledge, cognitive approaches provide various techniques, such as analogies, hierarchical relationships, matrices, and advanced organisers.

According to cognitive psychologists, learning is concerned less with behavioural respondents – what learners do - and more with what learners know and how they acquire it. Changes in behaviour do occur, but are perceived as indirect, rather than direct, they are outcomes of learning. Cognitive theorists address aspects such as the cognitive processes and higher-order thinking exercised by learners as they attain new knowledge and skills, as well as the internal mental representations learners construct as they actively acquire information. Some of the earlier cognitive applications were developed in the field of artificial intelligence.

Contributions of Cognitive Approaches to Instruction: During the 1980s, intensive research was undertaken in the realm of cognitive development applied to human learning, and by the 1990s the behavioural approach was giving way to a cognitive paradigm. Particular attention is paid to fostering higher-order thinking skills within learners. As theorists state, knowledge attainment comes not from mastering a hierarchy of skills, but from the use of critical thinking skills and the comprehension of fundamental concepts.

According to Reigeluth and Moore [128], cognitive education comprises methods that help students in recall and recognition of knowledge, as well as developing their understanding and intellectual skills, including metacognition. In addition, cognitive science views learning as the execution of internal cognitive processes, such as thinking, remembering, conceptualization, application, and problem solving. Learning entails a reorganization of the brains knowledge structures. In line with this approach, instruction is presented in ways that foster understanding, develop metacognitive skills within learners, and optimize the internal processes of human cognition. Attention is paid to:

- *Knowledge representation* - Cognitive activity enables humans to construct and manipulate internal mental representations or models, these are called schemata or schemas [77], frames [106] and propositions [4]. A schema or frame is a mental structure with slots for objects and their properties and links to represent relationships.

- *The relationship between prior knowledge and new knowledge* - proposing that the latter is acquired by accretion into existing schemas - refining and restructuring them.

- *Cognitive strategies* - to improve the design of instruction, including: chunking, frames, concept maps, advance organisers, metaphors and analogies, rehearsal, imagery, and mnemonics. These strategies can be hybridised or combined by the instructor, and can also be independently generated by learners to enhance cognition. Research shows that students who consciously use such strategies become better able to reflect on their strategies, plan, and monitor their own learning, and check their progress toward goals [156].

- *Active participation* by learners in the construction of their knowledge and development of skills.

- *Development of skills* that facilitate encoding, storing, and retrieval of information.

Ertmer & Newby [54] provide basic assumptions and principles of cognitive approaches that are related to course design. Table 3.2 shows relationships between these principles and possible course design applications. The Cognitive learning approach maintains that the learners existing mental structure be the point in which instruction begins. Ertmer & Newby [54] suggest that “Instruction allows learners to easily connect new information with existing knowledge in a meaningful way.” As described earlier, various cognitive

strategies, such as analogies, framing, outlining, mnemonics, concept mapping, and advance organizers are recommended for use in designing instruction.

Table 3.2: Cognitive learning principles and possible course design applications

Principles	Possible Applications
Active involvement of the learner	▪ Learner control
Use of hierarchical analyses	▪ Cognitive task analysis
Structuring information	▪ Outlining, summaries, synthesisers and advance organisers
Linking new information to existing knowledge	▪ Recall and recognition ▪ Relevant examples ▪ Analogies

Challenges in RBL: Cognitive approaches view learning as a process that is to acquire or reorganize the cognitive structure (i.e., mental model or schema) through which individuals process and store information. The learner tries to find a way to accomplish a task. The way that he or she is using the course may not be suited to the situation or the learner, which means it, is possibly not the best way. For example, the learner may have a poor knowledge structure because of memory loss, limited information/ misinformation, or interference. Therefore, to prepare the students to solve problems in the real world environment, Honebein [74] recommends using an authentic activity, or an activity close to the environment in which the learning will actually be used.

3.1.3 Constructivist approach to learning

What is Constructivism? Schuman [137] argues that "By using constructivist approaches to learning, human beings construct their own perspective of the world through their experiences and schema". Hannifin [68] notes that "Behaviourism and cognitivism both support the practice of analyzing a task and breaking it down into manageable chunks, establishing outcomes, and measuring performance based on those outcomes." Constructivism, on the other hand, promotes a more open-ended learning experience in which methods and results of learning are not easily measured and may not be the same for each learner. According to constructivism, learning occurs through the creation of meaning from experience [13]. Learning is affected by both learner and environmental factors. Constructivists also argue that situation is important to produce knowledge [26];[80]. Constructivism is applied when designing instruction to ensure that learners use prior knowledge 'more flexibly' rather than just recalling it [147].

As Ertmer & Newby [54] state, "Therefore, memory is always under construction as a cumulative history of interaction" because concepts keep evolving and "each new use of new situations, negotiations, and activities recast it in a different, more densely textured form" (p. 63). Transfer of learning is facilitated by providing authentic tasks to the learner.

Contributions of Constructivism to Instruction: The constructivist view maintains that learning content and its context should be considered in order to determine specific types of learning that are best supported by a learning theory [13]. However, Jonassen [82] propose that "constructivist-learning environments are most effective for advanced knowledge acquisition, while initial knowledge acquisition is better served by instructional techniques that are based upon traditional course design models". The main goal of instruction is to design a learning environment that allows the learner to elaborate and interpret information.

Ertmer & Newby [54] suggest five assumptions of constructivism that are directly relevant to designing instruction and their application to course design.

> The First assumption is "an emphasis on the identification of the context in which the skills will be learned and subsequently applied" (p. 65). An example of this assumption is to anchor learning in meaningful contexts.
>
> The Second assumption is, "an emphasis on learner control and the capability of the learner to manipulate information". Learners are required to actively use what is learned.
>
> The Third assumption is "a need for information to be presented in a variety of different ways" (p. 65). The way it is used to design instruction allows the learners to revisit content at different times for different purposes in rearranged contexts. The Fourth assumption is, "supporting the use of problem solving skills that allow going beyond the information given" (p. 65). An example of this assumption includes presenting alternative ways of representing the problems.
>
> The Fifth assumption is "assessment focused on transfer of knowledge and skills" (p. 65). Based on this assumption, new problems and situations are presented differently in the design of instruction, compared with the initial instruction

Challenges in RBL: Like Behaviourism and Cognitivism, some challenges, when applied to a RBL environment, are expected. For example, constructivism basically leaves the students to find out how to do something for themselves. However, we may want to engage the learners in constructing a new concept by showing them how to do it, and explaining it when necessary. We may want the students to find out a concept for themselves, but we can also facilitate knowledge construction by showing them how to make that discovery. Constructivists assume that there is no information or knowledge outside the human mind. Let's assume that an instructor explains how to do a piece of work, giving several examples. According to constructivism, the instructor's lecture (information) is not transformed into real knowledge (construction of knowledge) until it is absorbed by the mind of the learner. If we follow this assumption, however, there is no way in which the instructor can ensure that the subjective sense-making process taking place in the mind of the students is similar to his or her own.

3.2 Developing learning theory from first principles—conversation theory

As we described above, behaviourism, cognitivism and constructivism have their own contributions to the different learning environments. There are also challenges when they are used in RBL. Thus it is important to know these different learning theories, and then we can find the best way to do course design of RBL.

From the review of three learning theories, many ideas and principles are overlapped in the learning process. The principles of the three of them can be mixed to design RBL courses. In addition, Ertmer and Newby [54] argue that "the three learning theories of thought can in fact be used as taxonomy for learning". According to their descriptions, "behaviourist strategies can be used to teach the 'what' (facts), cognitive strategies can be used to teach the 'how' (processes and principles), and constructivist strategies can be used to teach the 'why' (higher level thinking that promotes personal meaning and situated and contextual learning)".

We now propose a unifying framework for the three learning theories. Conversation theory (CT) as put together by Pask[117] can serve to unify these three learning theories. George has the similar aim to unify the three learning theories. He proposes the theory of Connectivism[62]. He argues "Connectivism is the integration of principles explored by chaos, network, and complexity and self-organization theories"[62]. Interestingly, he draws on the work of Luis Rocha on self-organisation, which itself draws directly from Pask's CT.

Pask and his colleagues developed CT from the cybernetics framework[117]. It tries to explain how learning occurs in both machines and living organisms. There are some first principles of CT which are:

- **"The environment contains no information. It is as it is". "Everything that is said is said by or to an observer."[153]**
- **Learning is constructive and conversational**
- **"Man is a system that needs to learn." "Teaching is the control of learning[115]."**

In this section, we are going to describe CT in more detail in order to gain a deep understanding of CT.

3.2.1 How does learning occur?

The concept of learning in CT has a direct lineage from the early cybernetic information theories. Wiener [157] defines "cybernetics as a science of control and communication theory". Cybernetics considers that a feedback model can be applied to any open system. All elements of the system are interconnected as a whole. This is generated through the exchange of information or modes of communication. The connections of those elements can allow the system to be self-correcting or we could say "to learn". Feedback is the central mechanism in the system.

Following cybernetics, the world can only be represented within the system. An observing system cannot be instructed by direct transfer of knowledge. "***The environment contains no information; the environment is as it is***" [154] (p. 263). Thus the system constructs knowledge by itself actively on the basis of its interactions with the environment.

CT regards the study of human beings as a process of adaptation because humans are self-organising systems. Like all other biological organisms, this kind of self-organising system is dynamic and needs to survive and evolve in a hostile world. These systems can survive because they can adapt to their worlds and become informed about how their worlds work[139]. Learning is a biological adaptation that happens incidentally while the system is in the pursuit of need-satisfying goals, for example to feed itself.

From this viewpoint of learning as adaptation, learning is an automatic behaviour of humans. It is an ongoing process in every human beings life. When a person feels bored about their environment they will respond automatically and actively seek out novel and different environments. **"One cannot not learn"** [138]. ***"Man is a system that needs to learn." "Teaching is the control of learning."[117].*** The desire to learn as human beings is strong, because we can feel satisfaction with ourselves after learning. We set ourselves goals consciously. We try to achieve the goals via learning. We create meaning from our experience. We use our mental activity to code and structure information that we have and use it to solve problems. We practise our knowledge and skills. We reflect and converse with other people about our knowledge and conceptualise our knowledge. So we come together in order to facilitate our learning. When this occurs teaching is happening. We also try to engage in tutorial dialogues and peer to peer discussions to enhance our learning [138].

From this viewpoint of adaptation in CT, we also can say learning is stimulated by the outside environment, which can result in responses from the learner. Here, it is similar to the point of view of behaviourists which is that the stimulus-response pattern of behaviour is manifested in the learner's reactions. From the viewpoint of the 'meaning' of CT, the view of cognitivism is similar to it, that learning involves the execution of internal cognitive processes, such as thinking, remembering, conceptualization, application, and problem solving. Learning entails a reorganization of the brain's knowledge structures. After reflection and conversation about CT, we can see that the learning of constructivism is similar in many ways. Constructivists believe that individuals are intrinsically motivated to seek information and exploit it to facilitate learning [68] .

3.2.2 What is knowledge?

In the educational field, learning means to acquire "knowledge" [138]. Different researchers use different ways to conceptualise forms of knowledge. Scott [138] states: "Bloom [20] distinguishes knowledge between "knowledge", "skills" and "values". There are also a variety of sub-types of "knowledge" that are distinguished. Gagné proposes a descriptive theory of knowledge defining five categories of learning outcomes, each of which requires different instructional treatments and different conditions of learning for the outcome to occur [7];[60] . Romiszowski's [132] classification is even more complex. He

distinguishes ‘facts, procedures, concepts and principles as four main kinds of knowledge, and cognitive, psychomotor, reactive, interactive as four main kinds of skill’. There are also further subdivisions within these two classifications.”

All of these categories and classifications of knowledge provide us with a good understanding about knowledge. However that is not to say that it is always easy to apply them in a practical teaching or learning environment. For example, it is difficult to judge what kind of knowledge belongs to a particular type of category according to the above classifications. Thus it is not easy to assess students learning results sometimes. Hence we shall avoid this complicated categorization of knowledge.

CT uses a simple way to distinguish knowledge. As Scott [138] describes, “One particular distinction is used, familiar from the time of Aristotle onwards, the distinction between ‘knowing why’ (theoretical, conceptual knowledge) and ‘knowing how’ (practical, performance knowledge)”. In CT, the role of memory is a process of cognitive construction about knowledge at these two levels. As noted above, learning is an adaptation of humans with different environments. According to Scott [138], “as a consequence of adaptation, learning implies that new cognitive structures and processes are acquired.” In addition, CT believes that individuals are intrinsically motivated to seek information and exploit it to facilitate learning. Learners interpret objects and events in the context of experience, forming opinions and tentative conclusions. Mental representations change and develop; progressive refinements occur, so that understanding is a process not an event. CT promotes the idea that reflection and reconstruction is as important as activities that promote the mere assimilation of knowledge. Kolb also has a similar view to CT about these aspects of learning.

Kolb [93], using ideas from earlier work by Dewey[46], Lewin[100] and Jean Piager[125], provides "a comprehensive theory which offers the foundation for an approach to education and learning as a lifelong process that is soundly based on intellectual traditions of philosophy, cognitive learning and social psychology" [161]. The importance of reflection is emphasised by him. With reflection on experience students are avoiding making the same mistakes. The four-stage learning model of Kolb describes a learning cycle. It shows the process of translation of experience through reflection into concepts (See figure 3.1).

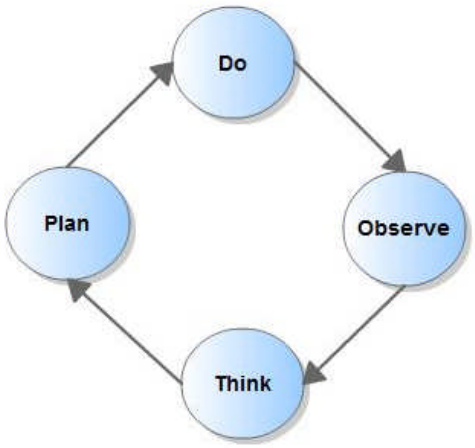


Figure 3.1: Kolb's experiential learning cycle

Source: Based on Jenkins [78]

As stated, CT views learning as the execution of internal cognitive processes, such as thinking, remembering, conceptualization, application, and problem solving. Theories in cognitive science also take the view that learning entails a reorganization of the brain's knowledge structures. In line with this approach, instruction is presented in ways that foster understanding, that develop metacognitive skills within learners, and optimize the internal processes of human cognition.

Double-loop learning refers to this kind of internal cognitive process. It is also known as the "two-cycle learning model" [129]; [139]. This model extends Kolb's [93] model with a second loop ("how-loop/knowledge" is the inner loop and the "why loop/knowledge" is as the outer loop) (See figure 3.2).

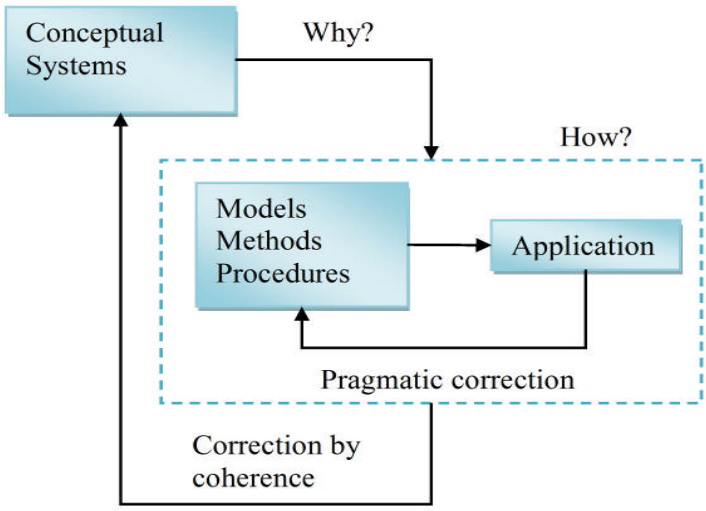


Figure 3.2: Rescher's 'two-cycle' model of learning
Source: Based on Scott[138]

In the external loop of the 'why' cycle, existing conceptual knowledge integrates new conceptual knowledge to form a coherent whole. In the inner loop of the 'how' cycle, new models, methods and procedured are constructed, practised and corrected practically [139].

3.2.3 Learning as conversation

In CT, learning is conversational and constructive. Learning happens via conversations and communications between learners and teachers, between the learners themselves or learners and learning contents. Here, we can define two roles as the basic roles in our learning. They are the role of teacher and the role of learner. Teachers and learners are said to be 'in conversation' with one another [139].

The role of teacher is seen as an effective teacher to facilitate learning. The teacher can be a person but also the role of teacher may come in the form of books, computers or

other resources. Communication is an essential role in a learning process, because the respondents can understand and negotiate with each other among differing perspectives.

In CT, learners communicate or converse with their other peers and the teacher in order to achieve a learning process known as “coming to know”. As stated before CT cannot only be used for human teachers and learners, but also for technology-based teaching support systems, that are in many respects like RBL environments. According to Pask’s definition of a ‘mind’, he states that it encompasses any organisation which is expressed in a mutual language[118]. Scott [138] highlights that “this mutual language is able to accommodate commands, questions and instructions which give rise to thought, feeling and behaviour”. This kind of mind can be human but also could be a computer environment or even the scripts of theatres and the manifestos of politics.

A ‘conversation’ can be constituted in a learning process. The important thing is that the learner is able to formulate a description of his actions and himself. Furthermore, the learner also must be able to extend that description and carry forward their understanding to a future activity which is at a higher level of knowledge. In addition, in order to “come to know” conversations must be able to be used by a learner or system with himself and others. These conversations are about what he knows. The understanding of knowledge is developed and externalised by these learning conversations. In order to be engaged in a productive conversation, the respondents of learning need to access the subject which is a common external representation. This representation can be a schema, structure or other learning resource that allows topics to be identified and discussed.

In CT, learning is an ongoing conversation. As Scott [138] says, “Learning is a continuous conversation with the external world and its artefacts, with oneself, and also with other learners and teachers. The most successful learning comes when the learner is in control of the activity, able to test ideas by performing experiments, to ask questions, collaborate with other people, seek out new knowledge, and plan new actions.”

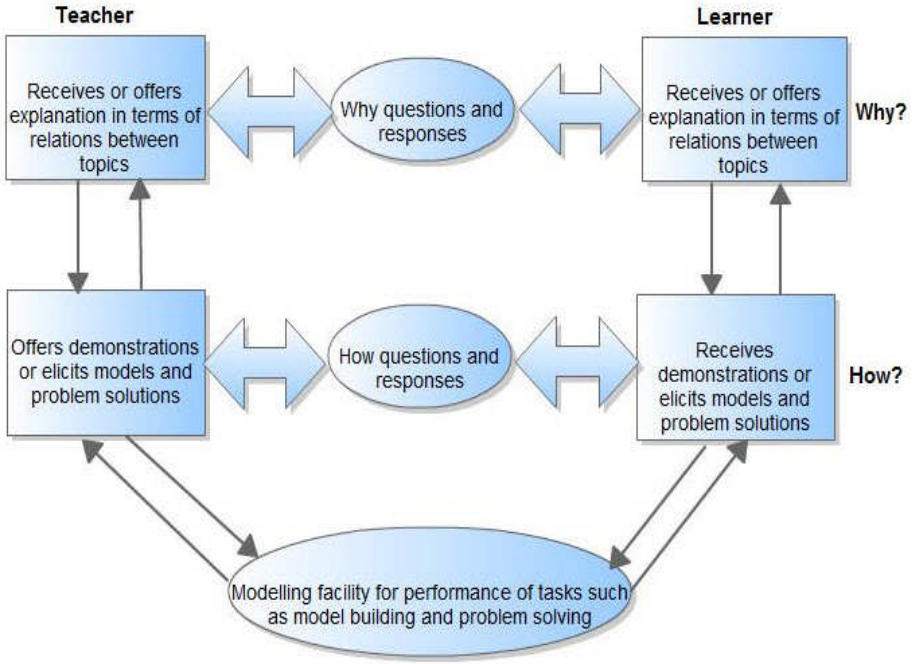


Figure 3.3: The 'skeleton' of a conversation
Source: Based on Scott [139]

Figure 3.3 shows the framework or 'skeleton' conversation. There are two levels of conversation in CT. The lower level is about the 'how' of knowledge. The upper level is about the 'why' of knowledge. At the lower level, the conversations between respondents are mainly about the performance of some educational activities. For example, respondents may wish to carry out a scientific experiment. They will discuss it with each other and have a shared understanding of the phenomenon. Some questions are likely to be explored by them at this level of learning, which are about "What is happening here?" and "What do we do next?" They set goals and build and refine practical models to test those goals. The whole process can be a cycle. At the why level, the discussions between respondents are mainly about the implications of the actions. They get a deeper understanding about the activities. They can propose and describe possible theories. They also can adjust explanations. They will be interested in questions like "Why did that happen?" and "What does this mean?" Pask [117] refers to the 'why' of learning as 'comprehension learning' and the 'how' of as 'operation learning'.

Often, there are external representations to mediate these conversations and to assist the respondents in negotiating agreements. These external representations could be images and texts in notebooks or shared concept maps [138]. Pask [117] notes that 'how' and 'why' mix together in ordinary conversation. Respondents have different perceptions of each other's needs when they have conversations about topics. They may or may not want to justify, exemplify or demonstrate those topics. Here is an example to describe the distinction between 'how' and 'why'. If we want to understand 'bicycle', an operation is about to know 'how' to ride it and a comprehension is about to know 'why riding is possible and many uses'.

Pask [117] also defines a generic term 'Modelling facility' to describe the resources that enable the topic to be exemplified by a teacher. Here, the teacher can use non-verbal

demonstrations. Typically, there are verbal commentaries about 'how' and 'why' that can accompany these non-verbal demonstrations. In turn the learner can carry out tasks and solve problems set via this modelling facility. Verbal commentary may also be provided about the 'how' and 'why' of topics. Here modelling facilities can be different resources. As Scott [138] notes, "Modelling facilities can be laboratories, computer based micro-worlds and simulations or parts of the real world". Often, topics are modelled in mental creativity. When the teacher 'talks' about topics, the learner constructs a 'mental model' about the topics. Vice versa- when the learner 'talks' about the topics, the teacher constructs a mental model. The mental model of the teacher is about the learner's mental model. According to Pask[117], understanding a topic means that 'teachback' can be provided by the learner about the topic. He or she provides both non-verbal demonstrations and verbal explanations of 'how' and 'why'. 'Mastery learning' means the learner should understand not only a partial piece of a topic but the full topic.

There are also other researchers that have discussed 'learning as conversation'. Pask's model is explained by Harri-Augstein and Thomas [139] in a different way. 'Self-organised learning' is the basic idea of Harri-Augstein and Thomas. It means to help learners 'learn-how-to learn'. They propose a 'full learning conversation' in which there are three main components [139].

- Why of learning? The conversation is mainly about the purpose that is the 'aim of learning'. This level of conversation is to encourage the learner to develop personal autonomy and accept responsibility for his or her own learning.

- How of learning? The conversation is about the procedure of gaining knowledge of a topic (for example, study skills are being discussed and a learner reflects on his learning experiences.)

- Why and How of a Topic? (Subject related discourse, as shown in figure 3.3)

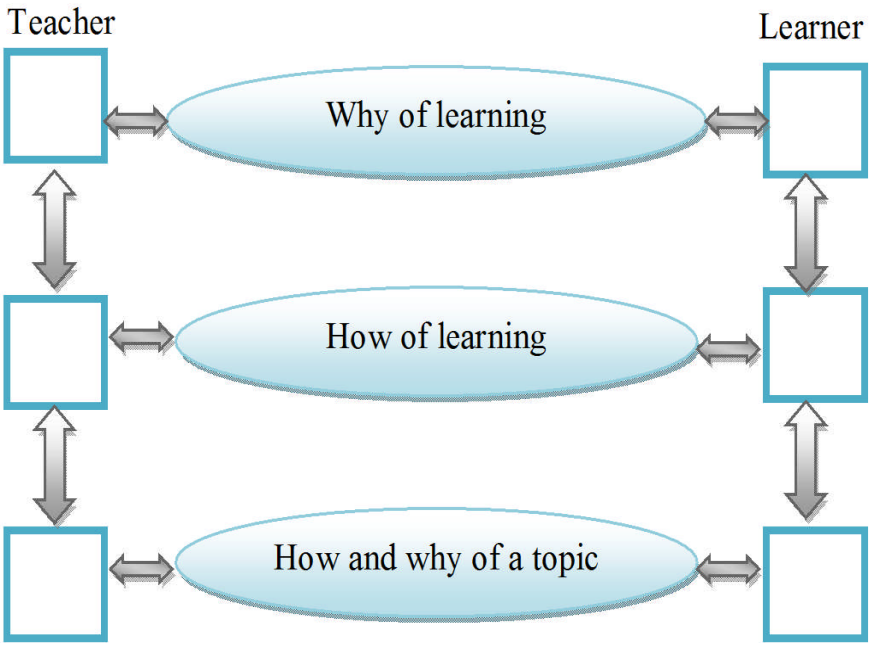


Figure 3.4: A full learning conversation (after Harri-Augstein and Thomas)
Source: Based on Scott [138]

Fig 3.4 shows the whole process of a learning conversation. It is an adaptive, conversational system that provides support (scaffolding)**.** The teacher and the student participate in the conversation. The teacher will give the student support by showing the subject-matter domain (why and how of topic?). Both them will converse with each other about the subject-matter at the two levels which are the how of learning and the why of learning. If both of them can reconstruct each others' mental ideas, 'self-organising' will occur. While the student is grasping the relative concepts within that knowledge domain, he or she can teachback to the teacher. In other words, it is a form of adaptive teaching: the teacher is both conversational partner and observer. The teacher always gives feedback to the students according to the conversations between them.

Laurillard[98] also regards the process of learning as an on-going interaction and conversation between learner and teacher. Drawing on CT, she has developed the 'conversational framework, which is shown in figure 3.5. The framework identifies the activities necessary to complete the learning process.

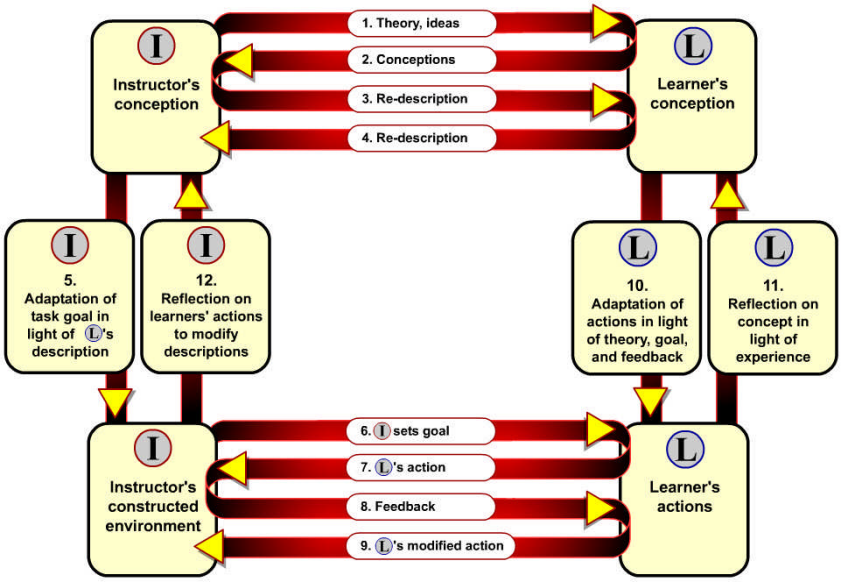


Figure 3.5: The 'Conversational Framework' developed by Laurillard[98]

'Learning as Conversation' is the fundamental learning idea of CT as discussed previously. Learning, under the behaviourist view, is the strengthening and adjustment of the associations between stimuli and respondents. This can be done by personalising instruction by supplying feedback contingent on the individual learner's response - as may be done by programmed instruction and computer-based learning systems. These acquired associations impact upon new situations, depending on how many and which kinds of associations were acquired in previous situations. A response learned as an association to one stimulus may generalise to other stimuli that are similar.

In the cognitive perspective, learning is assumed to depend on acquiring an abstract mental representation in the form of a schema or structure that is invariant across various situations. This general schema has to be acquired in initial learning, along with practice in applying it to examples. Constructivist conceptions, on the other hand, assume that knowledge is individually constructed or socially negotiated. The purpose of constructivist learning environments is to engage learners in constructing knowledge based on their interpretations of experience, and to make meaning from a model which comprises a problem, question, or project as the focus of the environment, surrounded by various interpretive and intellectual support systems. The learner's goal is to solve a problem or complete a project.

CT includes the views of learning of the three above learning theories at some points. Pask[117] describes two stages of knowledge acquisition in CT: procedural and conceptual knowledge. Procedural learning comprises the initial stages of knowledge assembly, basic skills, and integration in a domain when learners have little prior knowledge about a content area or skill. It is also about the how of knowledge. Conceptual knowledge acquisition is about learners acquiring a higher level of knowledge (why of knowledge). CT applies Knowledge and Task Analysis to combine these two stages of learning. Behaviourist approaches support these two stages, which often involves basic practice and feedback. The cognitive perspective emphasises mental representation in the form of a schema or structure, which accords with the method of Knowledge and Task

Analysis of CT. Constructivist approaches relate to the two stages as well: knowledge is constructed via being socially negotiated.

In this section, different learning theories have been reviewed. Course design models will be discussed in terms of these learning theories in the next section.

3.3 Course design principles and models

As a part of an overall effort to incorporate fundamental elements of course design principles and processes, a number of course design models which are based on the above learning theories are discussed in this study. According to their underlying views of knowledge and learning, the models of course design can be classified as three main categories.

- Objectivist Course Design Models (OCDMs)
- Constructivist Course Design Models (CCDMs)
- Conversation Theory Course Design Model (CTCDM)

OCDMs and CCDMs are outlined by Moallem[107] and CTCDM is desribed as part of this study. Figure 3.6 below represents the relationship between the learning theories and the three course design models. OCDMs have been influenced by Behaviourism and Cognitivism, while CCDMs are based on Cognitivism and Constructivism. On the other hand, CTCDM is based on Conversation Theory and employs all three learning theories.

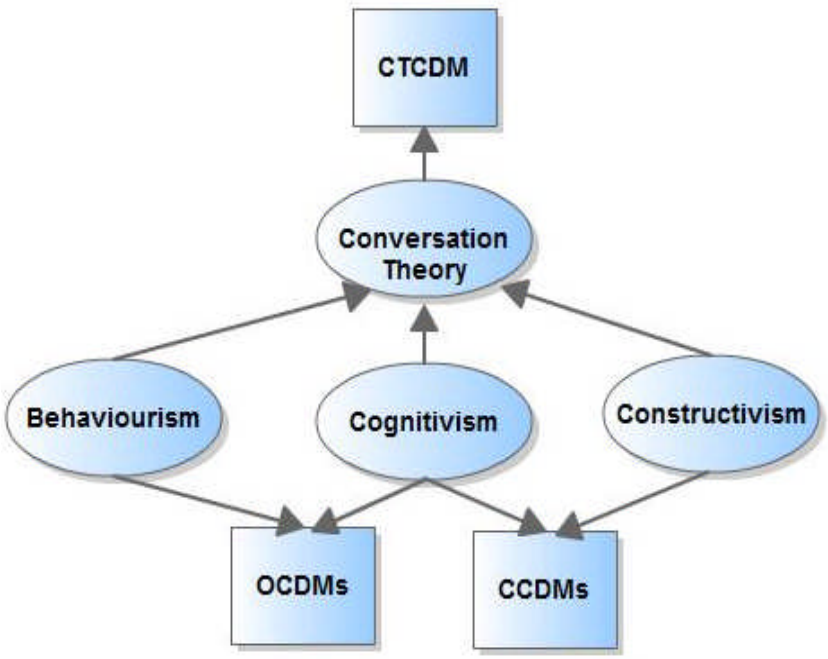


Figure 3.6: Relationship between learning theories and course design models

3.3.1 Objectivist Course Design Models (OCDMs)

The philosophical view of traditional models is from an objectivist's perspective is that knowledge and truth exist independently from the human mind. According to Moallem [107], objectivist design models put their emphases on "the conditions which have bearing on the course system (such as content, the learner and the instructional setting) in preparation for achieving the intended learning outcomes" (p. 115).

Saettler [134] states that, "The Instructional Systems Design of Dick and Carey [47] is based on behaviourism and Gagne, Wager, and Briggs' Principles of Course design[59] are based on cognitive science." Objectivist design models are based on both behaviourism and cognitive science. He also highlights that, "Behaviourism has contributed to traditional models by providing relationships between learning conditions and learning outcomes." [134]. In objectivist design models, learning success is measured by the behavioural outcomes. To develop those behavioural outcomes, a learning task is broken down into specific measurable tasks. On the other hand, Driscoll [50] notes that "The cognitive approach influences objectivist instructional models by emphasising the use of advanced organisers, mnemonic devices, metaphors, and learners' schemas as an organized knowledge structure".

Table 3.3 shows the design components that objectivist design models have in common, even if there are some differences among OCDMs [135]. As Goldstein & Ford [64] point out, these models take an objectivist view of the nature of knowledge in which emphasis is on "the specification of instructional outcomes precisely controlled learning experiences to achieve these outcomes, criteria for performance, and evaluative information" (pp. 22-23).

Table 3.3: The typical objectivist course design approach

Phase	Design Component
I	Conduct needs assessments
II	Establish overall goal
III	Conduct task analysis
IV	Specify objectives
V	Develop assessment strategies
VI	Select media
VII	Produce materials
VIII	Conduct formative evaluation
IX	Conduct summative evaluation

According to Dick & Carey [47], an objectivist apporoach to course design contributes to a successful learning outcome because it focuses on "what the learner is to know or be able to do when the instruction is completed," and provides a prescription about "the relationship between the instructional strategy and the desired learning outcomes," and it is "an empirical and replicable process" in which instruction is designed for use on as many occasions as possible (p. 11).

3.3.2 Constructivist Course Design Models (CCDMs)

Constructivist Course design models have their roots in cognitive science and social psychology [134] . Constructivists believe that the learner actively constructs knowledge

and truth, and focuses on collaboration, learner autonomy, reflexivity and active engagement [51] . According to this view, learners construct their own knowledge by actively participating in the learning process. In his 'Constructivist Learning Environment' model, for example, Jonassen [83] provides a number of design principles for implementing constructivist concepts such as cooperative learning, problem-based or project-based learning. He describes these design guidelines as: "1) Create real world environments that employ the context in which learning is relevant; 2) Focus on realistic approaches to solving real-world problems; 3) The instructor is a coach and analyser of the strategies used to solve these problems; 4) Stress conceptual interrelatedness, providing multiple representations or perspectives on the content; 5)Instructional goals and outcomes should be negotiated and not imposed; 6) Evaluation should serve as a self-analysis tool; 7) Provide tools and environments that help learners interpret the multiple perspectives of the world; and 8) Learning should be internally controlled and mediated by the learner" (pp. 11-12).

Figure 3.7 presents the design components that CCDMs have in common, even if there are some differences among them [107]

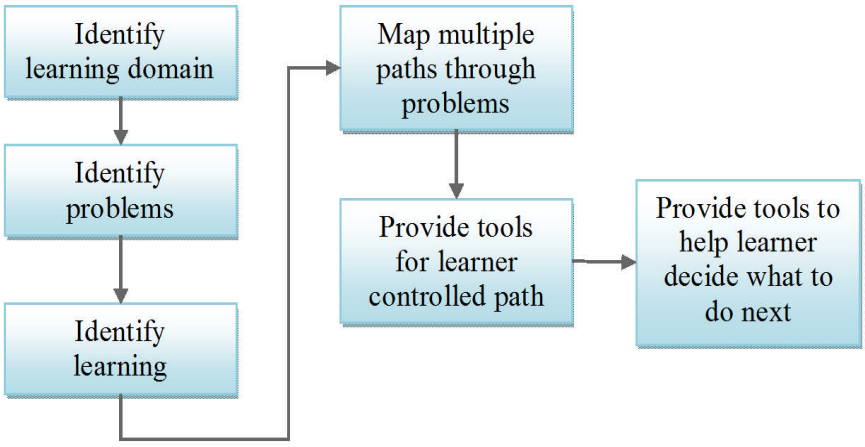


Figure 3.7: The design components of CCDMs

3.3.3 Conversation Theory Course Design Model (CTCDM)

Objectivist and constructivist design models have their own characteristics. As described before, a predetermined learning outcome is stressed in the objectivist design models. This learning outcome is mapped into the learner's mind via an intervention in the learning process. Constructivists believe that the learner actively constructs knowledge and truth, and focuses on collaboration, learner autonomy, reflexivity and active engagement. A principled approach to course design which is based on CT can be seen as an integration of the above two course design models.

According to the framework of a full conversation as we described before, we believe a RBL environment should have four major components [138]:

- Learning outcomes should be described.(it can also be referred to as outcomes)

- Course content should be specified. Course content is a subject-matter domain, which describes knowledge, skills and desired learning experiences.

- What learning designs will be employed? This covers issues about the sequences of the learning experiences, choices of resources and media for delivering learning experiences and the design of dialogic activities to encourage and reinforce effective learning.

- How to do the assessment. This includes formative and summative assessments.

These four components embody conversational learning that is essential for effective RBL and teaching. According to these four major components of course design; the essential principles of good quality course design based on CT are [138]:

- Learning outcomes and the specification of course content should be mapped clearly.

- There should be an analysis of course content, so appropriate learning designs can be specified according to the analysis of course content.

- Course content and assessments should be mapped clearly. It is similar to the mapping between learning outcomes and course content.

- There should be clear mapping between course content and assessment activities
    - The diagram below summarise these principles.

Figure 3.8 shows a framework for course design. All items of each the four components should map onto corresponding items of the other components

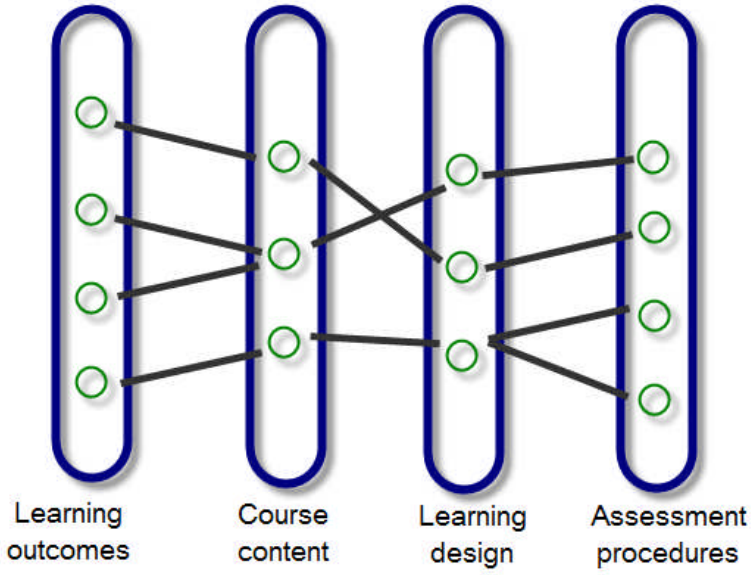


Figure 3.8: A framework for course design

Source: based on Scott [139]

The following sections will outline these components or steps of these first principles of course design.

3.3.3.1 Identify learning outcomes

A crucial part of successful course design is in determining which skills need to be learned before a student can demonstrate that he or she has mastered the course outcomes. Specifying what the learner is able to do after the instructional experience will not only help the designer choose or design instruction that works, it will also provide the tool for evaluating the effectiveness of instruction. Clearly stated outcomes also allow the student to know what is expected in terms of performance. Once needs or gaps have been identified, and it has been determined that instruction is the best way to address these needs, then learning outcome statements can be developed.

Briggs and Wager [25] (p. 39) recommend using Gagne and Briggs'[58] five domains of learning outcomes as a basis for developing outcomes. These domains are verbal information, intellectual skills, cognitive strategies, motor skills and attitudes. Domains one to three are analogous to Bloom's [20] cognitive domain, domain five can also be referred to as Bloom's affective domain and domain four, motor skills, as Bloom's psychomotor domain. Briggs and Wager[25] outline the domains and sub-domains of learning outcomes, as well as the appropriate vocabulary of 'capability verbs' and typical 'action verbs' associated with each type of outcome.

CT distinguishes the two main categories of learning outcomes, cognitive outcomes and performance outcomes, corresponding to our earlier distinction of the 'why' and 'how' of knowledge. Performance describes what the learner can do after the learning that he or she could not do before the learning, that is, the new capability that the learner has acquired as a result of instruction. Cognitive outcomes describe the conceptual understandings that a learner acquires.

Attitudinal outcomes refer to the higher levels in the 'full learning conversation' shown in figure 3.4, clarification of why the learning is important and support in being an effective self-organised learner and 'reflective practitioner'[136].

Leaning outcomes should correspond with course contents and, vice versa. Normally, there are different "chunks" in the course content. There should be a corresponding learning outcome for each chunk of course content. In this study, we use Knowledge and Task Analysis methodology to reveal the relationships within bodies of subject-matter domain. We will describe it in more detail in a following section.

Learning outcomes can be advance organisers and make the learning apparent to the learner. Biehler [17] and several others theorised that acquisition or learning will be facilitated when material to be learned is organised and that organisation is made apparent to the learner. The beginning of a unit of learning outcomes contain outcomes to the material which is relatively general (an advance organiser). This helps the material become meaningful for the learner because an advance organiser provides

some predictable patterns and familiarity. Learners can also benefit from having the opportunity to cognitively organise instructional materials. Here, learning outcomes can be very useful, we also need to give students advice about study skills and learning strategies. For example, this advice can be presented within the Course Guide.

3.3.3.2 Course content

This section will describe how to carry out Knowledge and Task Analysis in order to have a clear conceptual structure of the course content.

There are many discussions about different kinds of knowledge and various forms of analysis and representation knowledge [110]. Declarative knowledge is described as knowledge of some object, event, or idea; it is also understood as knowledge of, "knowing that" or conceptual knowledge (our preferred term). Procedural knowledge is regarded as "knowing how". Both conceptual and procedural knowledge, having once been acquired with a conscious awareness, may become tacit over time.

Jonassen [81] also distinguishes the structural knowledge that describes how declarative knowledge is interconnected. In our usage, conceptual knowledge encompasses both declarative and structured knowledge. We refer to the analysis of conceptual knowledge as "knowledge analysis" and the analysis of procedural knowledge as "task analysis". In this context, we can cite the "Law of the Simple and the Easy" (Confucius, c. 600 B.C., cited in Scott[138]). "What can be explained can be explained simply; what can be done can be done easily". The law refers to the wisdom of explaining and doing things in small steps.

Jonassen and colleagues in two books review the state of the art of knowledge analysis and representation. In Jonassen [81], methods for analysing and representing structural knowledge are presented. In Jonassen [83], methods for analysing and representing tasks are reviewed. Although these reviews are quite comprehensive, we believe that, conceptually, they suffer from two major flaws: They are that the two kinds of analysis are treated as if they are unrelated and also the book states that task analysis covers aspects of both declarative and procedural knowledge.

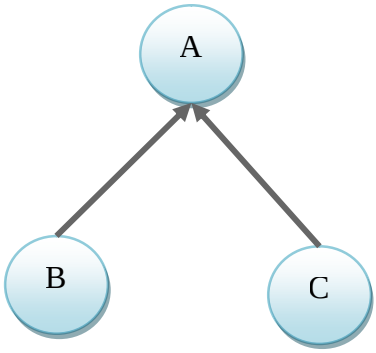
With respect to the latter point, Jonassen [81] distinguished five general classes of task analysis: job or performance analysis, learning analysis, cognitive task analysis, content or subject matter analysis and activity-based methods. Each of these general approaches to task analysis focuses on different aspects of the job or task being learned. Job analysis focuses on the behaviours engaged in by the performer. Content analysis examines the concepts and relationships of the subject matter. Learning analysis approaches focus on the cognitive activities required to efficiently learn. Activity analysis examines human activity and understanding in context. Cognitive task analysis focuses on performances and their associated knowledge states. Content analysis and learning analysis address declarative knowledge and structural knowledge. Job analysis, activity analysis and cognitive task analysis addresses procedural knowledge.

In this research, Knowledge and Task Analysis methodology is adopted as the knowledge representation. The researcher feels that all the differences and overlaps are

unsatisfactory and confusing. We believe the Knowledge and Task Analysis methodology, derived from CT, is a more satisfactory approach for knowledge analysis and representation both conceptually and practically. This is because the CT methodology makes a clear distinction between conceptual and procedural knowledge and contains steps that ensure analysis of the two kinds of knowledge are carried out in complementary and coordinated ways.

In the previous section on CT theory, we could see that understanding means both knowing conceptual knowledge (knowing why) and performance knowledge (knowing how). The stated learning outcomes should describe two main categories of learning outcomes—cognitive outcomes and performance outcomes. According to Scott [138], "a description of learning outcomes goes some way towards specifying course content." Topic maps are used in this research to describe how that content is structured.

A topic map is also a kind of concept map. In a topic map, topics are represented by the following; Relations of topics are showed by arcs (links). For cognitive outcomes, entailment structures are used to show the logical relations between topics. These entailment structures are special kind of concept maps. As Scott [138] notes, "entailment structures show 'what may be known': how new topics are understood, explained or defined in terms of other topics". A simple example is shown in figure 3.9.



Understanding A entails
understanding B and C
B and C are pre-requisites for
understanding A

Figure 3.9: A simple entailment structure
Source: Based on Scott[138]

For performance learning outcomes, a task analysis is carried out to show the procedural knowledge—how of knowledge. The task analysis specifies task structures. According to Scott [138], "task structures show "what may be done". They show the "procedural knowledge" or "performance competencies" that someone who understands a particular topic is deemed to have." (Figure 3.10)

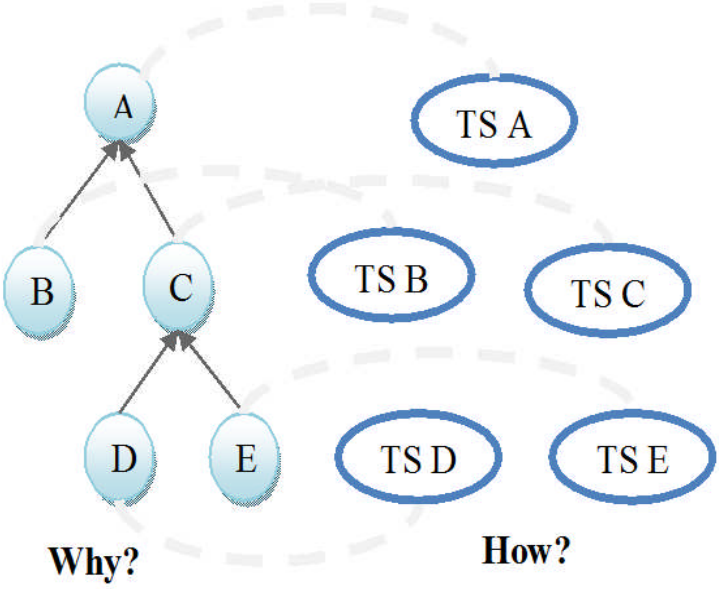


Figure 3.10: Topic map
Source: Based on Scott[138]

There should be a task structure to associate with each topic in an entailment. The task structure gives operational meaning to the topic. For example, for the topic ‘bicycle’, the student could be asked to how to ride a bicycle or assemble a “bicycle” from component parts.

There are a variety of ways to represent task structures [138] . For example, a flow chart can be used to show sequences of operations of tasks and a precedence chart can show order relations between the goals and sub-goals of a task. Figure 3.11 shows a precedence chart and figure 3.12 shows an example flow chart.

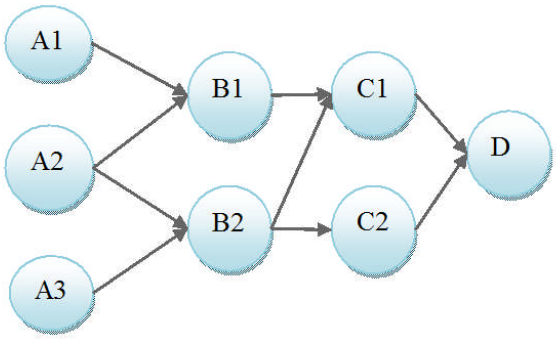


Figure 3.11 : A precedence chart
Source: Based on Scott[138]

Figure 3.11: A task structure is represented by a precedence chart which shows the possible orders. What sub-goals need to be achieved before achieving goal D? In this example, the sub-goals of B2 need to be achieved before the sub-goals of C1 and C2. Both of the sub-goals A2 and A3 need to be achieved before B2 in any order.

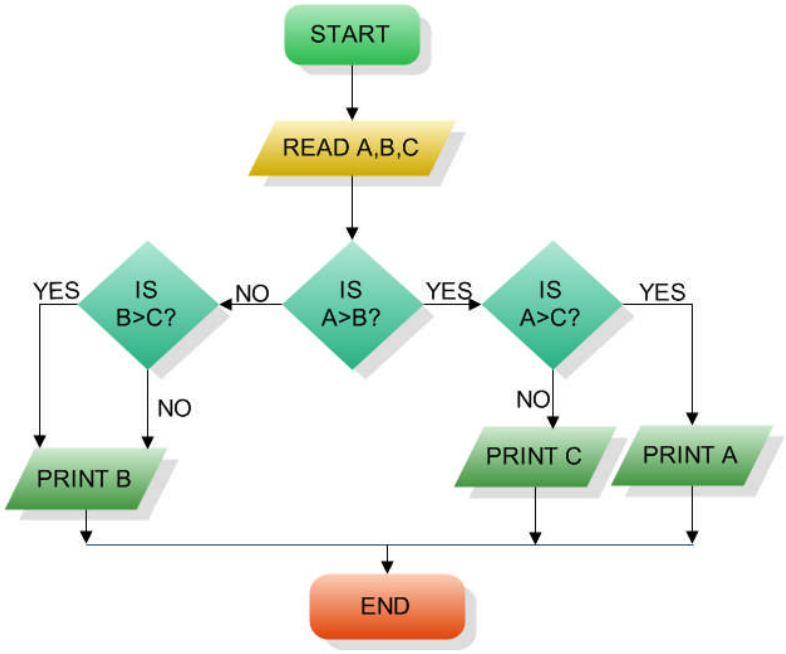


Figure 3.12: A flow chart example

Figure 3.12: It is useful to use a flow chart to show the order of operations that are repeated linearly and frequently. This example shows the result of the output is the biggest number among variable A, B, C.

Entailment structures have related analogies between topics or subsets of topics that are similar with tasks structures. An analogy is depicted in an example is in figure 3.13.

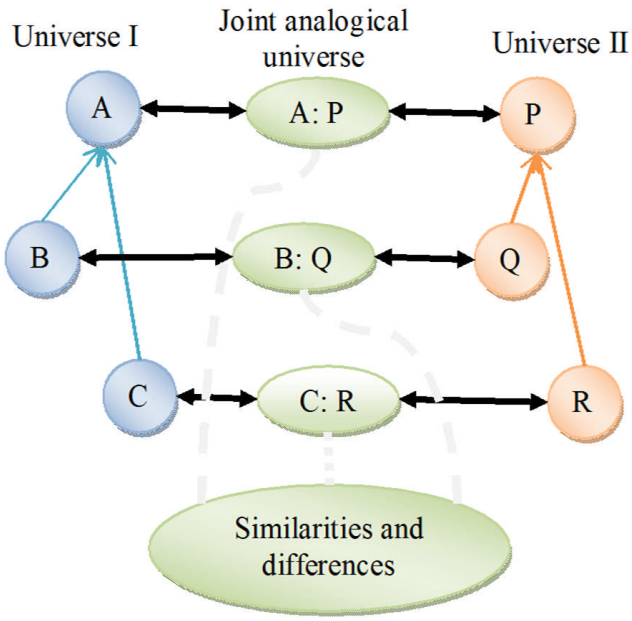


Figure 3.13 : Two distinct universes are related by analogy
Source: Based on Scott[138]

Two distinct universes are related by analogy as illustrated in the diagram above. For example, if Universe I is concerned with "means of a bicycle"; Universe II is about "means of a car", the joint analogical universe could be about "controlling". Topics B and C are entailed under topic A. Both topics Q and R are entailed under topic P. "A is to B and C" and "P is to Q and R" are an overall analogy. For example, "Bicycle is to wheels and brake as car is to wheels and brakes". The key similarity is one of function; the key difference is one of structure.

If we want to compare two or more subject areas or topics, analogy is a good way to do it. We can find similarities and differences between the topics. From analogies, we can also find how one set of topics are transformed into another set of topics or how it is derived from another set of topics [138]. When analogies are expounded, we may adopt different narrative sequences according to the students' needs and the demands of explanations of the subject matter. For example, a teacher describes similarities and differences between two universes at an early stage. At a later stage, students can demonstrate what are the similarities and the differences via operational study. Gradually, the demonstrations of the analogy will relate to operational experience and then a conceptual description can be provided.

3.3.3.3 Learning design

After the content has been decided, learning design should be carried out according to the learning outcomes and the course content. Scott [138] notes that "learning design means taking decisions about teaching sequences and tactics". He describes tactics as "the use of a number of tutorial aids, devices and procedures".

'Advance organisers' is one of them. Ausubel [8] argues "advance organisers help learners become aware of how a course is structured and what kinds of learning experience is on offer". There are many forms to carry out advance organisers. For example, a listing of learning outcomes, textural introductions or maps of course content can be advance organisers to give students meaningful learning. Scott [138] also notes that "icons or other devices may be used to clearly signpost to the student where he or she is within course materials". The effectiveness of the learning materials also can be used to achieve this goal. Expository text, activities and self-assessment questions are good tactics. As Scott [138] states, "expository text may be accompanied by activities and self-assessment questions, designed to reinforce understanding and mastery and also to provide formative feedback".

Activities and self-assessments may overlap with the strategy of the course's assessment. Shuell [142] highlights that "if students are to learn desired outcomes in a reasonably effective manner, then the teacher's fundamental task is to get students to engage in learning activities that are likely to result in their achieving those outcomes … it is helpful to remember that what the student does rather than what the teacher does is more important in determining what is learned".

- Activities

In our course design, we emphasise the usage of activities to achieve effective learning.

Scott [138] stresses two particular points about effective learning. It is that effective learning is active and also that effective learning takes place when students are well-motivated and their interest is fully engaged with the subject matter at hand.

Students need to be positively encouraged to use different learning activities apart from reading a text. There are many research studies to support this point. As Scott [138] said, "it ranges from studies of the effectiveness of note-taking in lectures to laboratory studies of strategies for the recognition and recall of nonsense syllables."

There are many forms of activities. In our study, we define two roles of activities. They are the activities of operation learning and comprehension learning. Scott [138] defines that "the activities of operation learning are for practice and repletion in mastering skills and procedures; the activities of comprehension learning are for exploration, reflection and logical analysis in gaining a deep and rich understanding of concepts, principles and the relationship between them (comprehension learning combined with effective operation learning)."

According to these two roles of activities, they can be designed in a variety of ways. The simple activities are designed to let the student reflect on their learning briefly and perhaps to let the student make some notes or write up a short list. The extending activities are designed to give the student the chance to work through case studies or examples. Furthermore, the student can practice and consolidate their skills by activities.

No matter what kind of activities we want to design, it is essential that we make them clear to the student. Scott [138] argues that "we should let the student know why the activity is included, how much time he or she should spend on it and what form of response is required". A well designed activity can support students' learning effectively. Figure 3.14 shows how a lesson uses activities to achieve effective learning.

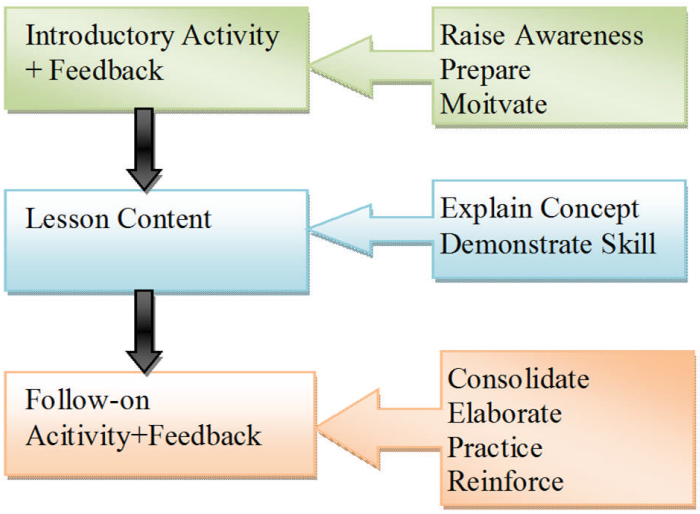


Figure 3.14: Using activities within a lesson to promote effective learning
Source: Based on Scott[138]

- Development of Media

The development of media refers to a rational selection and application of media in accordance with learning outcomes through course design. If learning materials need to be developed then a method for media selection must be identified.

The course design of this research concerns the analysis of knowledge and the task of topics to be taught or elements of information to be learned. In each case, the sequence and structure of the topics should be identified, giving insight into the way they should be taught. Learning design concerns how to teach. The suitable selection of media can improve the effectiveness of teaching and learning. There are some factors that influence the selection of media according to the course design of our research.

a. Learning outcomes

There are different levels of learning outcomes from the course design. CT mainly concerns two levels of knowledge. When we expect a learner to know the 'how' of a topic, we should give him or her opportunities to practise that topic during instruction. Thus, if the learner is expected to be able to give examples about a certain topic, he or she should be presented with examples during instruction. This means learning outcomes may imply particular media.

b. Cost-effectiveness

When a particular media is chosen, cost-effectiveness should be not forgotten. Would less expensive media be just as effective as more expensive means? Given the standard costs for the preparation of each type of media to be used, we can estimate the costs of media production with a fair degree of accuracy.

c. Practicality and time

Assembly times for each group of lessons or for each specific topic should be estimated before production times. Thus, in the case of time constraints, we might assign priorities so that the media most important to the effectiveness of the course is produced early and without delay.

3.3.3.4 Assessment

It is essential that learning outcomes are capable of being assessed after the learning design. The means of assessment usually fall into two main categories: Summative assessment and Formative assessment. Both types of assessment can be used to motivate students and lecturers. According to Scott[138], "formative assessment provides information to the student about his or her progress with respect to particular course content"; "summative assessment gives an overall mark or grade that permits direct comparison with other students". Traditionally, summative assessment measures student achievement while formative assessment is said to enhance learning [101].

- What to Assess?

In CT, understanding means two levels of knowledge (how and why of knowledge). Effective assessment procedures should address both of these two perspectives of understanding of knowledge [138]. Which perspective should be emphasised more depends on learning outcomes. It is very important that the methods and criteria of the assessments need to match the learning outcomes which are designed at the beginning of a course.

In addition, Pask[116] argues that "what is essentially being asked for in assessment is that the student should be able to "teachback" what it is that he or she has learned". For performance outcomes, tasks demonstrating competence and skills can be carried out to assess students. For conceptual outcomes, "telling a story" is a good way to assess students. The story is about "what is being done and why" Scott [138].

- Self-Assessment Questions—Formative Assessments

"Self-study" is one of basic characteristics of RBL environments as we described before. "Self-assessment" is a vital ingredient of "self-study"[138] . Self-Assessment Questions (SAQs) are a kind of formative assessment which is different to summative assessment. In RBL environments, most students are autonomous learners. They need to be responsible with their studies. Their own progress of study should be assessed formatively. SAQs can help them in this. There should be encouragement for students to use SAQs, though students decide whether they make effective use of them.
SAQs are often at the end of lessons. In principle, they are similar with the activities, because they are of the same format as the forms. One important aspect of SAQs is that they relate to the lesson's learning outcomes directly.

Kolb [94] notes that "an effective learning environment should let students try out their understanding and obtain constructive criticism". It is necessary to provide feedback to students via formative assessments. According to Scott [138], there should be commentaries after SAQs. Advice about what to do if wrong answers are made should be included in the commentaries. It will help students learning more than from getting things wrong. Scott also highlights that there should be positive feedback with SAQs. Feedback should be encouraging and understanding too. As he notes, "Try again!" is a good way to advise students to do it once more.

As a kind of formative assessment, it is important that SAQs should cover the content of the full lesson effectively. This is so that it can give students confidence in that they have fully understood and mastered a lesson's content before they go on to start a new lesson. In addition, we also need to encourage students to review their own learning progress. To achieve this they can go back to the learning outcomes and use summaries. Both of these can help them to check their understanding.

SAQs and feedbacks are the foundation stones for active learning. However, it can become predictable and boring if SAQs are always of the same type. If questions and feedback become predictable, learners will begin to skip them. For example, it would be very tedious, if all SAQs were four-option multiple choices. We should not be limited

by the common types of SAQ found in learning materials. Learners should be given plenty of variety. There are two things we should keep in mind when we set SAQs for our students, in which one is that students can get something interesting to do and the other is that they can get feedback for what they have done.

Here is a list of a few different kinds of SAQ:

- Multiple choices: learners make decisions about which option (s) are correct, or which are 'best'. They are then provided with feedback on the options they selected, and on the rest of the options if they are interested.

- True-false: a rather limited sort of multiple-choice. The choice is limited to two.

- Fill in the blanks: learners write missing words or numbers into spaces left for them.

- Completion: learners add things to material already provided. This can be a more open ended and complex form of filling in blanks.

- What's wrong with this? : Learners play detective and search for 'mistakes'.

- Put these in the right order: (sometimes called sequencing and prioritising): learners are more interested in this type of question.

- Decision making: learners are provided with information then asked to decide what it means, or what course of action to take, and so on.

- Open ended: these are easy to write, but often hard to respond to. All possible right answers cannot be given.

➢ Summative Assessment

The purpose of summative assessment is to report, or put on record. They are a known record of the students' attainments. What did students study? Did they pass or fail? What grades did they get? Such reports are usually for the benefit of other teachers, professional bodies or employers. Summative assessment is the end-of-course examination. The prime purpose is to establish what the learners have achieved—not to give them feedback that will help them learn. Sometimes, mid-course tests and assignments can also be used in a summative manner. They can contribute to the students' final grades, reports or 'portfolios'.

3.3.4 The whole process model of course design from first principles

Conversation Theory and CTCDM has been described and adapted to address different instructional situations, especially for RBL environments. In this section, a full course design model is presented according to CTCDM, while the model is an adaptation of CT.

The term "model" refers to a particular set of procedures used for carrying out a problem-solving process for a particular purpose. The whole process of the design of courses in this research will result in a model which will follow a particular sequence and ensure that all the components are designed to fit with each other.

The following diagram illustrates the course design model with all the necessary steps to design effective courses in RBL. Admittedly one cannot predict all the variables that may affect a designer's time, ability, resources and motivation to include all the steps outlined. Even with similar situations and design problems, a designer or instructor may decide to modify the model by skipping steps or combining components. However, to maintain the integrity of course design, one should not begin with a compromise, but rather an appropriate design which can facilitate the most effective instruction.

There are several stages that are involved in this diagram. They interact with each other. It means the decisions of later steps can influence the earlier steps making it possible that some revision back and forth may be needed.

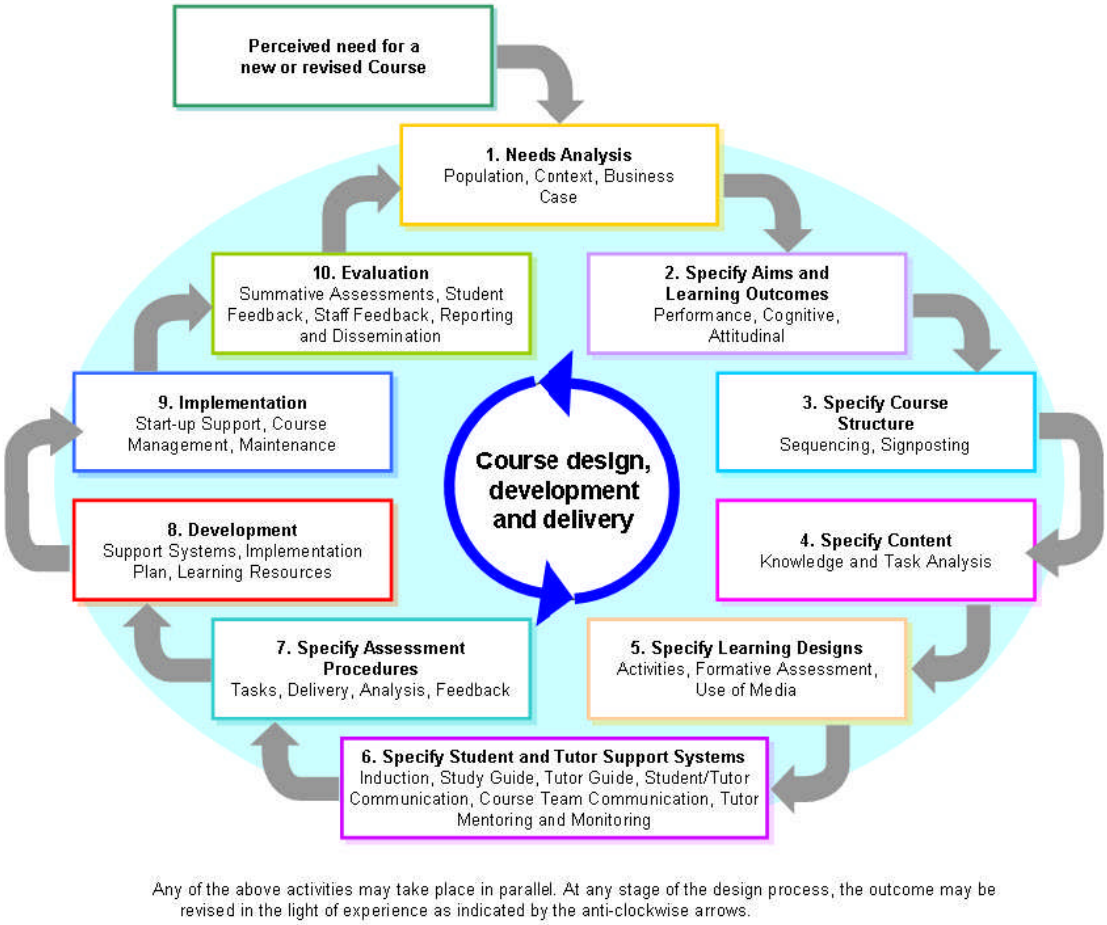


Figure 3.15 :Processes involved in course design
Source: Based on Scott[137]

There are some features in this model of course design that contribute to and account for the effectiveness of the course design. They are:

- All components of the instruction are planned to work together to achieve the goals and outcomes of the instruction.

- Components are analysed and developed in a planned sequence; although each is reviewed again as new components are planned.

- The entire design process is orderly but flexible. There is both "feedback" and "feedforward" in iterative cycles of work.

- The key step of Knowledge and Task Analysis is supported by a well defined methodology[140].

- Evaluation is carried out where empirical data is gathered to test assumptions underlying the work and to test the effectiveness of the course design. This data is gathered while the instruction is being planned and tried out, and also after the instruction has been field tested. These efforts are called evaluation.

The following chapter uses a case study to outline these components or steps of this course design model. Particular attention is paid to those stages which apply first principles of course design. The case study includes in depth evaluation studies.

4 CASE STUDY 1 —MILITARY KNOWLEDGE COURSES

Quality RBL courses for the British Army have been developed as part of The Review of Officer Career Courses (ROCC) initiative. There are two parts to these RBL courses, Military Knowledge 1 and Military Knowledge 2 (MK1 and MK2). The development of these courses has been guided by course design from first principles, with Dr Bernard Scott acting as pedagogical advisor. In this section, the overall process of the course design for MK is described.

4.1 Needs Analysis stage

Briggs and Wager [25] and Kaufman [86] indicate that a needs assessment can help to determine whether instruction is the most favourable method for addressing a particular gaps in knowledge, attitudes, or behaviour. It can also examine a particular identified population who, while part of a larger group, may have specific needs or differences that can set them apart and warrant a different type of instruction. The needs analysis phase also determines high levels of design goals that can guide the entire design process. In this first phase, of needs analysis stage for the MK courses, requirements specifications were drawn up[103].

The whole mission of the MK courses is to be part of life long learning for officers in the British Army. Figures 4.1and 4.2 show the ROCC concept. MK1 and MK2 feature as distance learning components of ROCC in stage 1 that follow residential courses held at the Royal Military Academy at Sandhurst (RMAS).

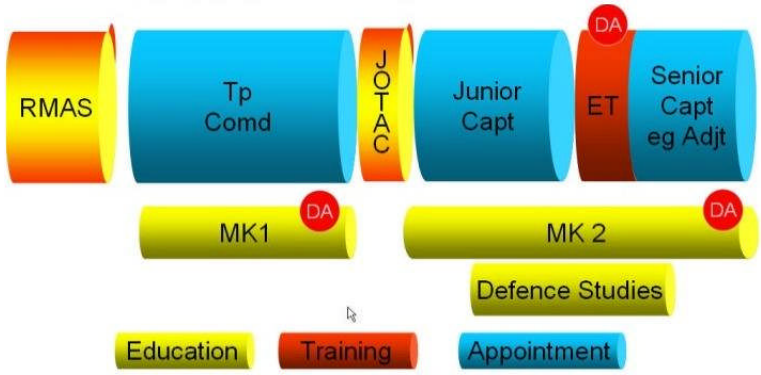


Figure 4.1: ROCC concept-stage1

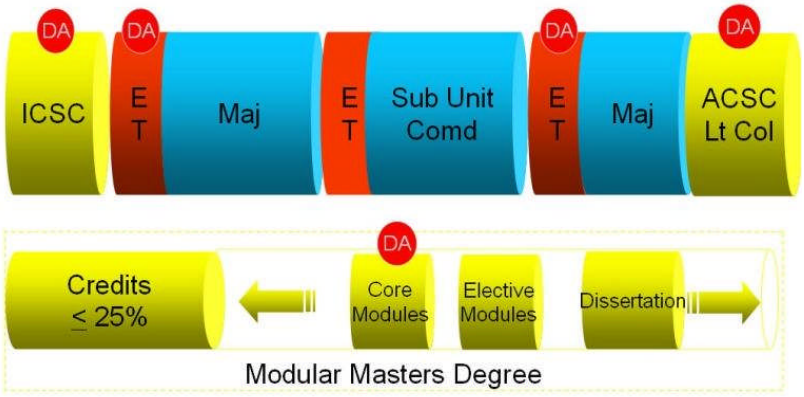


Figure 4.2:ROCC concept-stage2

Officers must complete MK1 successfully to qualify for promotion to Captain and for attendance on the Junior Officer Tactics Course (JOTAC). On leaving JOTAC, officers are inducted onto the MK2 course which is designed to be undertaken in the first 2 years after promotion to Captain. Officers are required to complete MK2 successfully in order to qualify for promotion to Major and for attendance on the Initial Command and Staff Course (Land) (ICSC (L)). Following that, officers may choose to participate in another distance learning programme, known as the Modular Masters Programme (MMP). Our second case study, below is an evaluation study of the course design used for the MMP courses.

Now that ROCC has been fully implemented the term Officer Career Development (OCD) has been adopted to refer to the whole process of officer education and training. The various components continue to be reviewed and evolve as content is updated and course structures are modified. The descriptions here of the MK and MMP courses refer to how they were at the time that the case studies were carried out.

The following were the objectives of the MK project.

- To establish a sustainable framework for the design and development of effective learning materials in support of MK, which will allow suitable quality cycles and approval processes to be applied

- To provide systematic support for the authoring process, planning, development, and maintenance of course material

- To provide an authoring environment to support the creation of course material and to support the development of multimedia assets

- To provide robust storage, asset and intellectual property management facilities for all course and multimedia components.

The project to develop the MK courses is has been completed and the courses are now in a continuous maintenance and update phase.

4.2 Development stage

For the development and maintenance of the MK courses,, a project team was built. This integrated project team consists of the Project Manager, the Technical Lead, the Network Engineer, the Content Management Specialist, the E-learning Co-ordinator, the Multimedia Specialist, the Production Manager, Librarians, the QA lead (Quality Assurance)/Project Assurance, the Authors and SME's (Subject Matter Expert). Figure 4.3 shows the structure of the integrated project team.

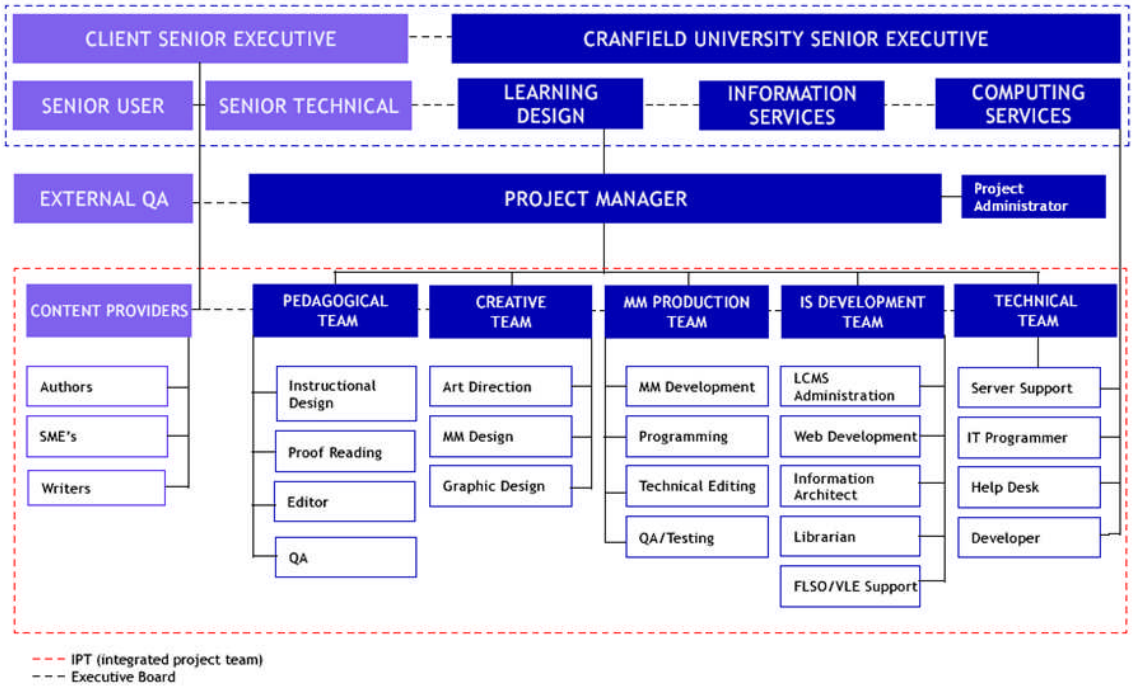


Figure 4.3: Integrated project team structure

The responsibilities of the team are as follows:

- **The Project Manager** is the executive officer responsible for making sure the deliverables are met within the timeframe of project plans, assessing the resources and budget requirements and for managing the team. The project manager liaises with the client (the MOD) and acts as an intermediary with the project team on a daily basis.

- **The Project Technical Lead** oversees the project from the technical perspective and works closely with the project manager and project team. The technical lead also ensures the technical strategy is sound and manages the system integration..

- **The Technical Engineers** are responsible for setting up and configuring the servers. The engineers need to ensure security and run reports.

- **The Content Management Specialist** has an understanding of Content Management Systems and is responsible for the documentation and status reports.

- **The Quality Assurance Lead** makes sure that the product delivered meets the criteria specified in the scope document and functional specification.

- **Multimedia Specialists** are responsible for media creation, creating individual components such as illustrations, video clips and animations for specific purposes etc.

- **Developers** produce functional items incorporating design, usability, and functionality and compile finished material.

- **Content Providers SME's** provide content specified under the requirements document, ensure access to the data, keep it up-to-date and edit as and when required. Content is approved by an editorial team.

- **The pedagogical lead** is responsible for specifying the overall pedagogic model. **Learning designers** (also known as instructional designers) are responsible for incorporating content into interactive lessons in accord with the agreed pedagogic model.

Figure 4.4 shows the process of the MK production.

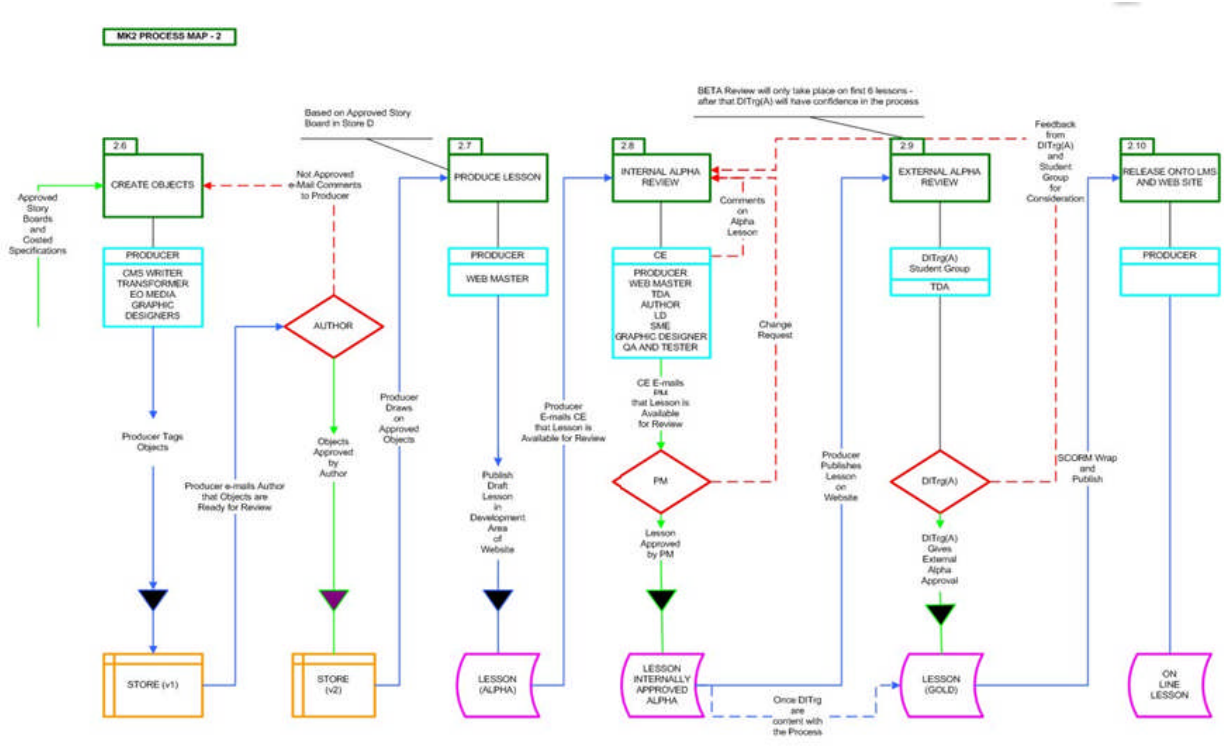


Figure 4.4: Production process map

The course design of MK follows the first principles as we described before. There are four important activities which are included in the design 1) learning outcomes, 2) content construction, 3) learning designs and 4) the assessments. The activities may be preceded one by one or at the same time. However, four development activities are

mutually influenced and should not be isolated from the other. The outcomes of the four activities are described below.

4.2.1 Learning outcomes

There is an area in each lesson of MK that contains the learning outcomes that students should be able to do on completion of the lesson. They are a useful indication of the subjects that will be the focus for the assessment at the end of each part. The following are the basic rules for writing the learning outcomes [138].

- A verb is contained, such as describe, explain, evaluate, analyse, apply, assess, outline and so on.
- Avoiding using vague words, such as appreciate, know, understand, be familiar with, acquire a feeling for, obtain working knowledge of and so on.
- Using the future tense.

The figure 4.5 shows an example of learning outcomes of MK courses.

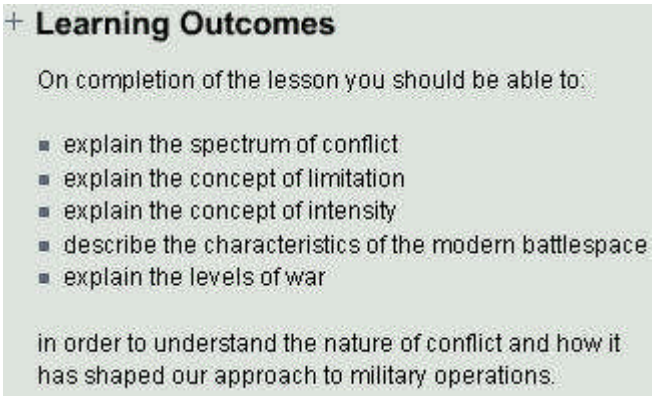


Figure 4.5: An example of learning outcomes

4.2.2 Content construction

After establishing the requirements and learning outcomes of the MK courses, content construction was begun. Based on the learning outcomes, the course structure was agreed. As Scott [138] notes, “Having a clear picture of course content helps ensure that the course is logically and conceptually coherent.” It can also make sure that the learning outcomes have been stated for the course corresponding to the course content. In addition, learning design will be easier, if there is a clear picture of the structure of course content. For example, developing activities, assessments and other assignments can be carried out according to this picture. Another benefit of having an overall picture is to facilitate communication between members of the course development team. This includes the decisions about how the work will be distributed [138].

The Knowledge and Task Analysis methodology was used to do content construction the for MK courses in order to have a clear logical conceptual framework of the course.

As we mentioned before, Knowledge and Task Analysis is a good way to expose logical and conceptual structure of the course. In MK, the Knowledge and Task Analysis was carried out in a way that mapped the content onto a particular course shell for teaching purposes. Figure 4.6 and figure 4.7 show the knowledge map and an example lesson map of the courses.

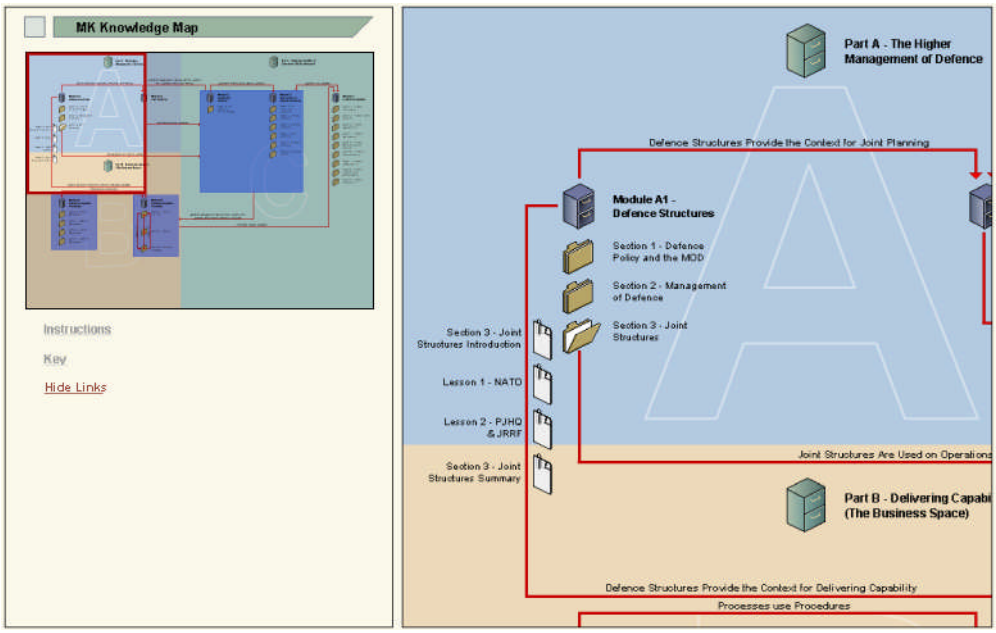


Figure 4.6: Knowledge map

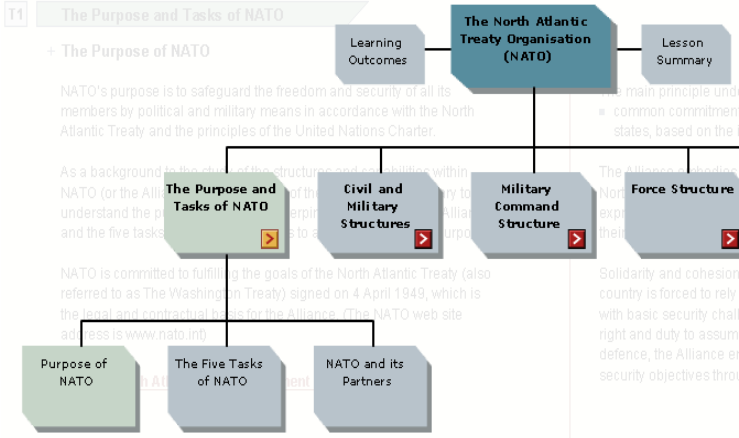


Figure 4.7: Lesson map

A "course shell'' was also used at this stage of course design. This was to ensure that particular "learning chunks" or "learning outcomes" could be fitted into the "shell" [138]. In the course shell of the MK courses, the smaller chunks in a typical course were distinguished. There were modules, units and lessons in this shell. Figure 4.8 shows the course shell of the MK courses.

- Modules, Sections and Lessons have titles
- Module contents listing
- Module Learning Outcomes (LOs)
- Module Introduction
    - Section LOs
    - Section Introduction
        - Lesson LOs
        - Lesson Introduction
        - Lesson Texts
            - Activities
            - Examples
            - Figures, Tables
        - Lesson Summary
    - Section Summary
    - Recommended further reading
- Module Summary
- Self Assessment Questions (SAQs), organised by Section
- SAQ answers, organised by Section
- References

Figure 4.8: Course shell

4.2.3 Learning design

Learning designs are methods used to teach the content. In the MK course design, a number of devices, procedures and learning aids were used to teach the content which had been clearly shown in the knowledge map and lesson map via knowledge and task analysis.

For example, 'advance organisers' [8] were used to help students be aware of how the MK courses were structured and what kinds of learning experience they would get from the courses. Maps of course content, textual introductions and a listing of learning outcomes were used to clearly let the student know where he or she is within the course material. Also 'i' icons were used to help explain extra information about course material. Different media were used to enhance the effectiveness of the learning materials in the MK courses, such as Flash animation, videos and pictures. Meanwhile, other aids were included to support effective learning in the MK courses. These were indices, glossaries, copying and note taking. A study guide was also provided to students. The overall information of the course is described in this guide. The guide comes with a sample interactive lesson which explains how the course is organised and how it may be navigated. The study guide also gives some advice on study skill.

The figure 4.9 shows an example of the advance organisers used in the MK lessons

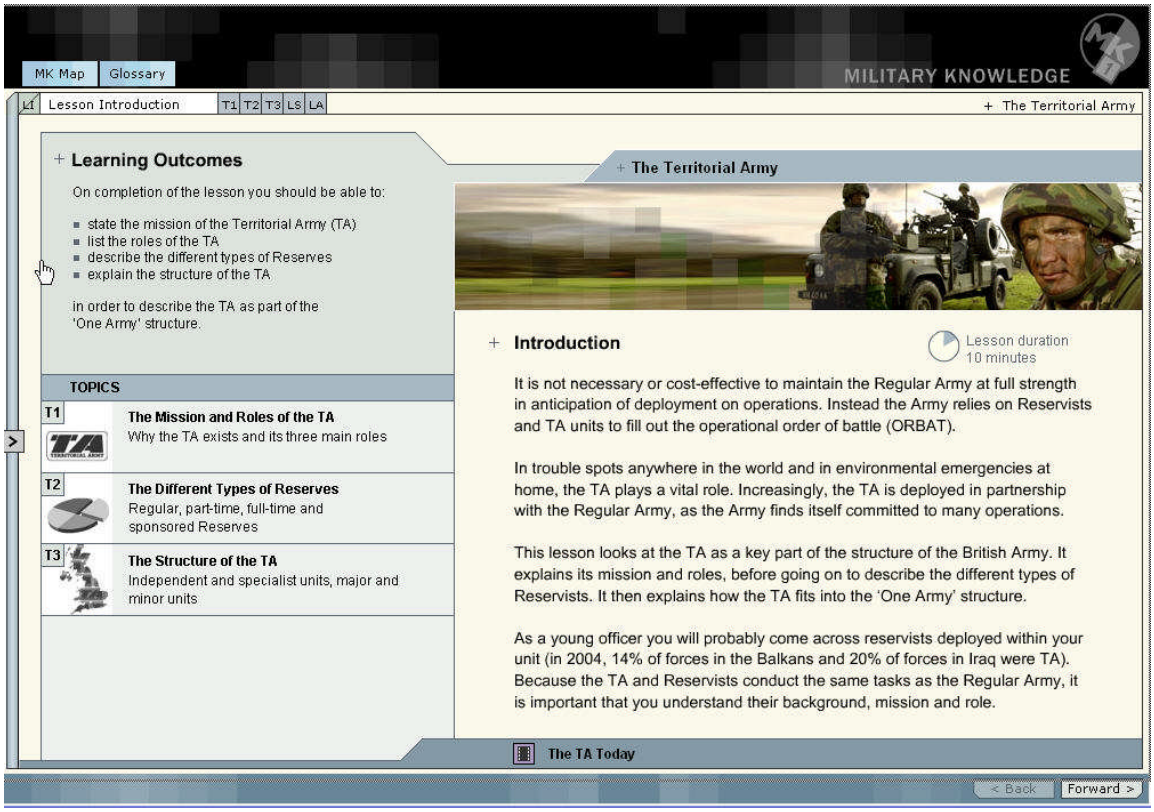


Figure 4.9: Lesson advance organisers (learning outcomes, topic listings, introduction)

Activities and self-assessment questions providing formative feedback were also used to reinforce the understanding and mastery of students. The activities within the MK lessons require the student to do something in order to stimulate their thoughts and consolidate their learning.

There are two levels of activities in MK courses. The lower level activities are mainly for operation learning which provide the chance for practice and repetition in mastering skills and procedures. For example, examples and case studies were given to students to practice and consolidate skills. The higher level activities are mainly for comprehension learning which combines with effective operation learning. These activities ask students to explore, reflect and do logical analysis. Hence students can gain a deep and rich understanding of concepts, principles and the relations between them.

With these two levels of activities, students can check whether they fully understand the lesson content. In addition, all activities included the following information in order to clear to the student.

- Why the activity is included
- How much time he or she should spend on it
- What form of response is required

The students are permitted two attempts at a question before the correct answer is revealed. There may be a discussion which would be included in the correct answer. Students can read the discussion, even if they do not fully complete the Activity. The time indicated is a guide that suggests the amount of time students should spend on the Activity. Figure 4.10 is an example to show the time of an activity while figure 4.11 is an example of the instructions for activities.

Figure 4.10: The time of activity

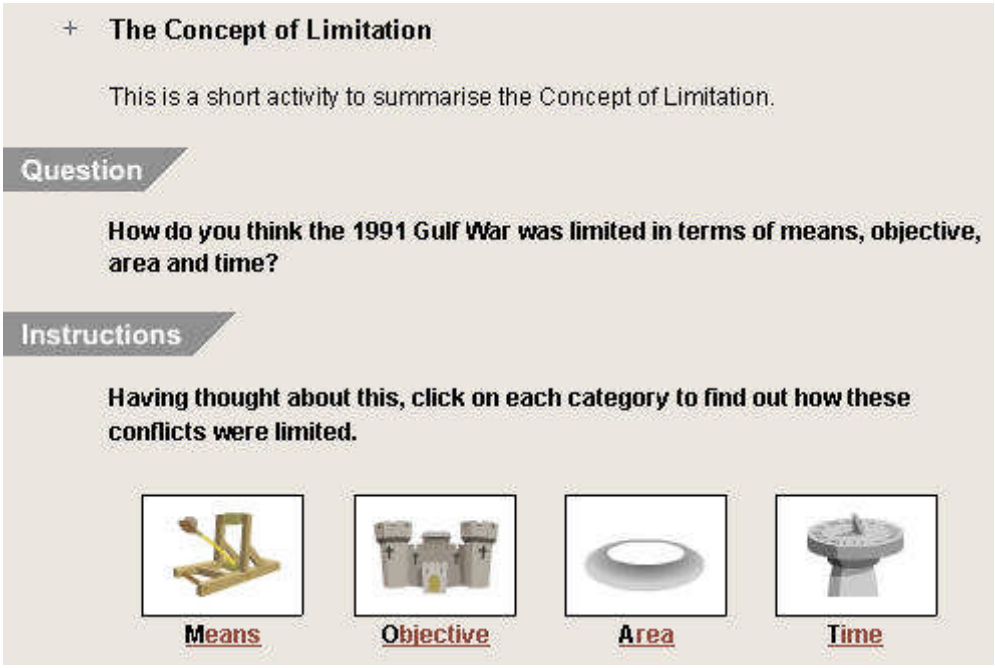


Figure 4.11: The instructions for an activity

The activities of the MK course are related to the learning outcomes, with at least one activity for each learning outcome. They are designed to be interesting, helpful, challenging and clearly signposted. There are a variety of forms of 'question styles' for creating activities in MK courses. For example, ticking items on checklists or tables, completing phrases or sentences, matching items from different lists, assigning items to particular categories, ordering items in terms of given criteria as a sequence or hierarchy, answering true/false questions, answering multiple choice questions. Figure 4.12 and figure 4.13 are two further examples of activities.

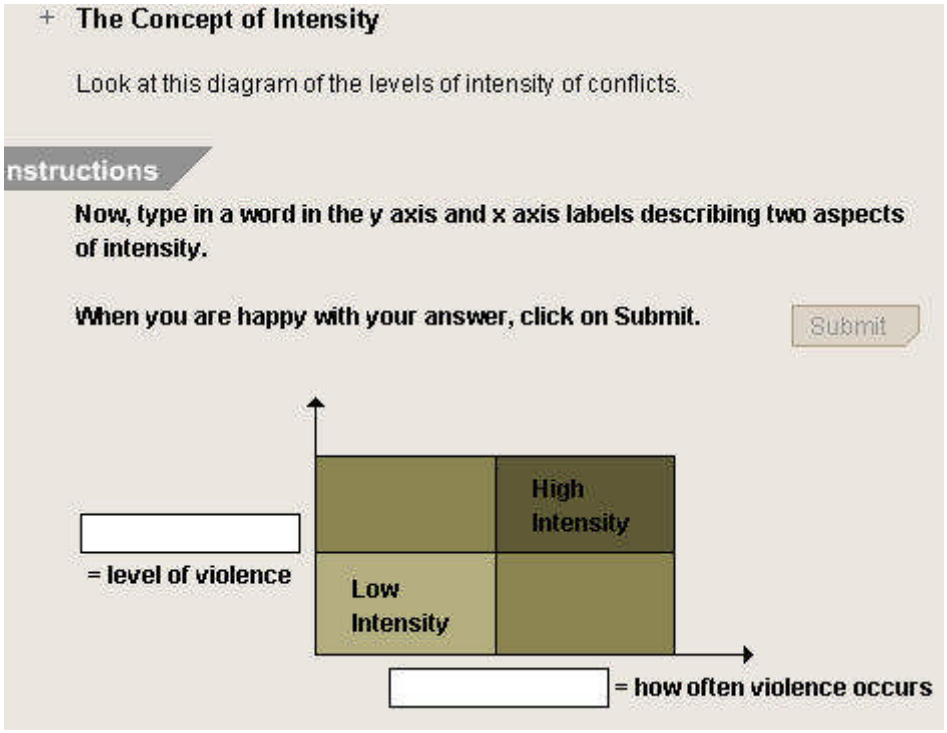


Figure 4.12: Completing phrases or sentences

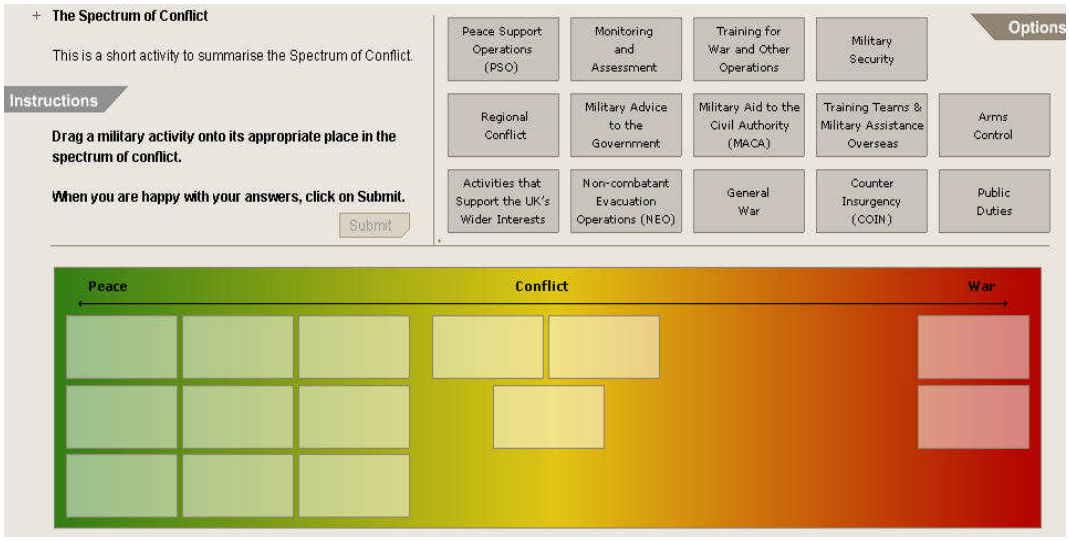


Figure 4.13: Matching items from different lists

After students finish the activities, formative feedback is provided. This can give them clues if they have misunderstood the activity they are doing. Figure 4.14 is an example of formative feedback.

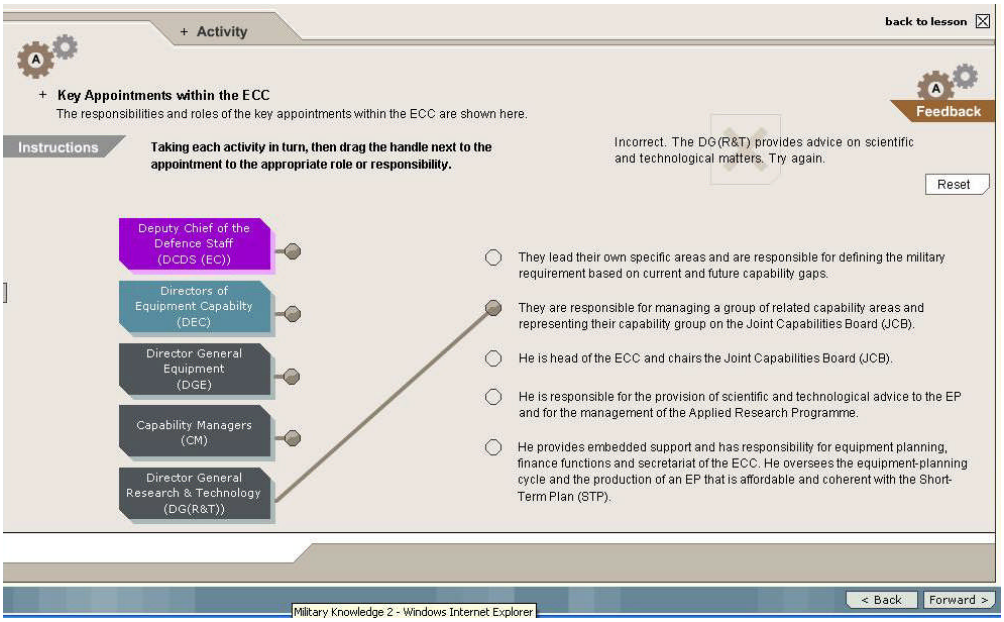


Figure 4.14: Feedback

At the end of each lesson, there is a Summary. The Summary refers back to material covered in the lesson and encapsulates the main teaching points. Students can use the summary to review the lesson that they have studied and for revision of the lesson. Figure 4.16 is an example of a Summary.

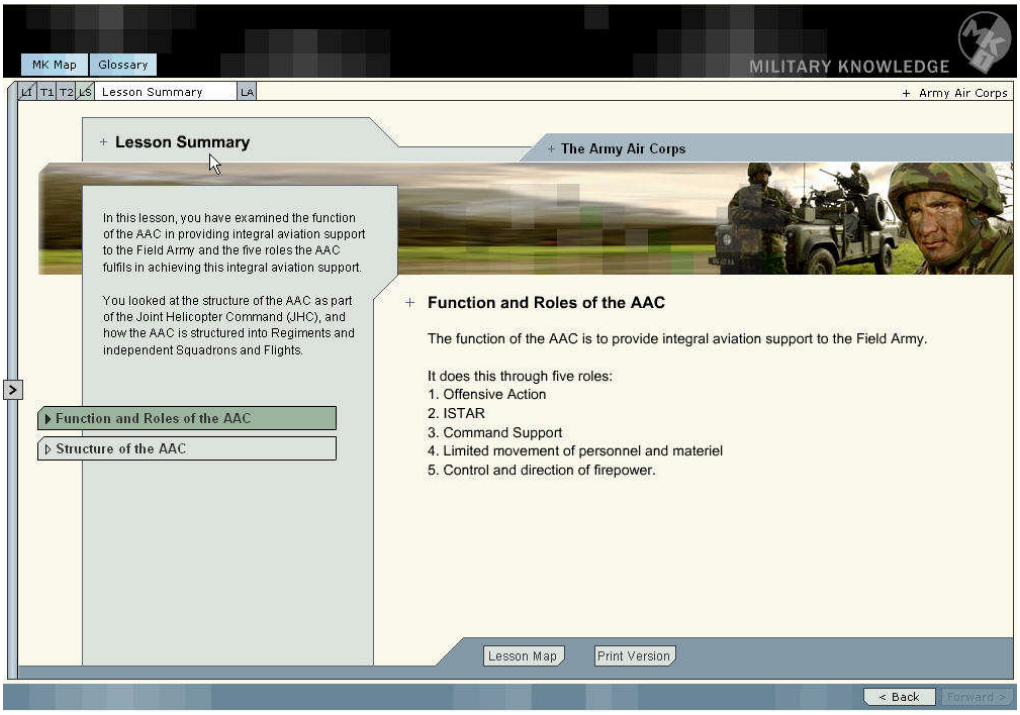


Figure 4.15: Lesson Summary

'Story boards' were used to do the learning design of MK courses. The storyboards were then passed to developers for lesson construction. Figure 4.16 shows an example of one of the storyboard pages for an MK lesson.

MILITARY KNOWLEDGE LESSON SCRIPT – MK1, Module 6, Section 1, Lesson 1

Step	Pane	Topic 2	Screen 2010	Template	Program & Design Notes	Design Elements	Asset
13	4	<title> The Reserve <text> A distinct reserve force must be nominated within a BG. The reserve should be an uncommitted force established and held to react to unforeseen circumstances. Another reserve must be constituted at the earliest opportunity.					117
5	3	<title> Rear Operation <text> Rear Operations for an attacking unit should involve: • assembling, moving and sustaining its forces without hindrance • protecting the sustainment effort • maintaining C2. The commander may need to protect his Combat Support (CS) and Combat Service Support (CSS) forces by carrying out Close Operations. You may now appreciate how difficult it can be to pin Deep, Close and Rear Operations to specific locations and events in the battlespace because of their tendency to become inter-mingled.					34
5	4	<fig title> The commander needs to protect his CSS by carrying out rear operations					119 DA1_AP002678

Figure 4.16 : Lesson storyboard

4.2.4 Assessment

The MK courses are summatively examined at the module level. There are is also a set of self-assessment questions posed after each lesson. These are designed to give students some idea of the types of question they will be asked in the final examination and also provide them with more formative feedback on their learning in addition to the feedback provided when students undertake lesson activities .

- Self-Assessment Questions

At the end of each lesson students can access sets of questions within the tab LA (Lesson Assessment). It is very important that students attempt these as they will help to indicate student's strengths and weaknesses and will also reinforce students understanding and long term retention. They are also very similar to the questions students will face as part of the MK Summative Assessment. Figure 4.17 is an example of the lesson assessments.

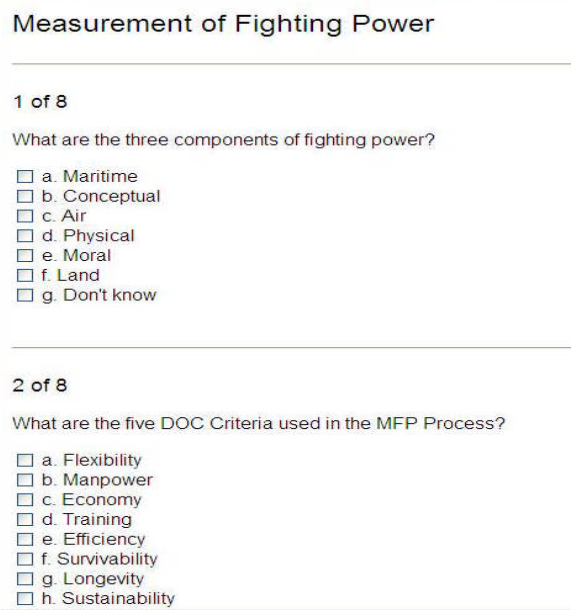


Figure 4.17: Lesson assessment

- The Summative Assessment

When students have completed a module they are assessed by means of an electronic Summative Assessment. The Summative Assessment is administered at unit level within the Army structure and takes place under exam conditions. The assessments are based only on the material contained in the MK courses.

Each student's unit has to ensure that he/she has access to a computer. He/she is set a question paper, chosen randomly from a question bank. To pass the MK Summative Assessment a student needs to achieve a score of 70% or more on each module. The Defence Academy, who run and administer MK, ensure that students' records are updated to show that they have successfully passed an MK course. If students fail the Summative Assessment they have to wait 48 hours before they repeat the Summative Assessment - each time they retake the Summative Assessment they are given a different set of questions.

4.3 Implementation stage

A RBL environment is built on a digital infrastructure. Boettcher and Kumar [21] note that "as with our physical infrastructure, this digital infrastructure needs to be designed, planned, built, maintained and staffed; therefore, it should be based on an architecture that depends on open, published standards, reusability of components, serviceability and maintainability". Implementation is the process of putting the course design in a real setting; the success of a course hinges on whether it is implemented as intended.

The Defence Academy e-learning platform (DAEP) that delivers the MK courses consists of the HarvestRoad Hive Content Manage System (CMS), Blackboard (Bb) VLE (Virtual Learning Environment) and the QuestionMark (Qmark) Perception assessment engine plus supporting infrastructure networked facilities. Figure 4.18 shows the infrastructure of the DAEP as it was first implemented. In 2007, the VLE and

assessment engine functions were taken over by the MOD's Defence Learning Portal (DLP). The functionality of the development and delivery infrastructure remains unchanged

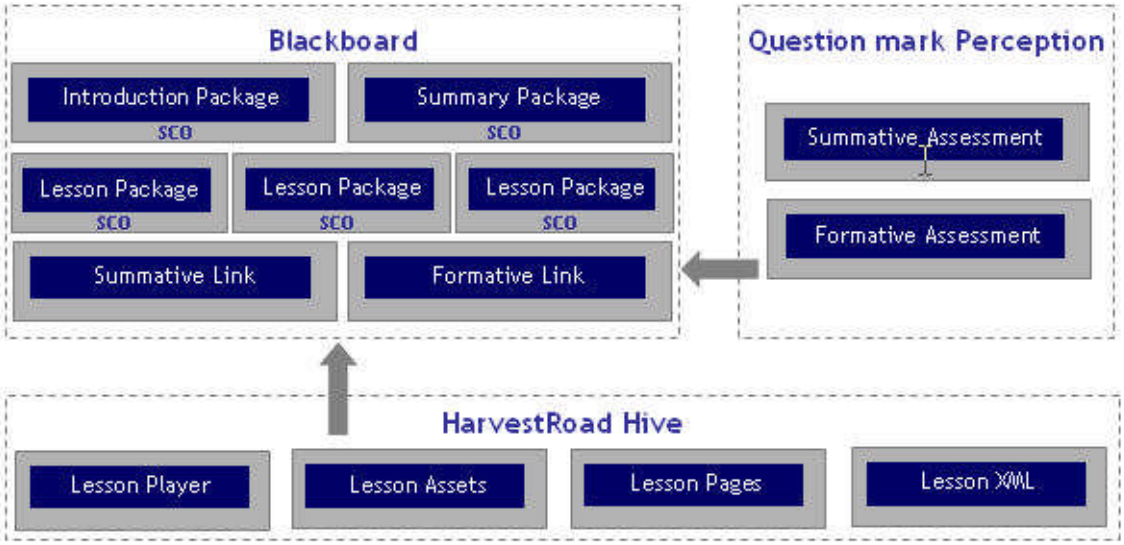


Figure 4.18: The infrastructure of MK e-learning platform

The DAEP is available for 23 in every 24 hours. It comprises:

- Hardware: three web server front ends (backup, development and launch) linked to the Defence Academy infrastructure, including Neoteris (the MOD-approved encryption device) to enable on-line delivery of restricted material. A web server for the learning content management system (LCMS) front end, database metadata back-end, file-system storage and the Blackboard VLE (Virtual Learning Environment).

- Software: Hive Content Management System(CMS) from Harvest Road, Blackboard VLE, Dreamweaver Courseware Development Tool and Question Mark Assessment Development Software Tool;

- On-line Access to Courseware (Launch Server): provides a means whereby Officers anywhere in the world can get free access to the launch server. The system is to be able to accommodate access by a maximum of 100 Officers at any one time.

- On-Line Access to the Development Environment (Development Server): provides a means whereby all members of the development team (internal and external) can access their area of workflow at any time. The system is able to accommodate access by a maximum of 30 members of the development team at any one time.

- Authentication: provide access and control through the MOD-provided LDAP Directory .

In this chapter, the overall process of course design of MK was described, which included the analysis stage, development stage and implementation stage. In the next chapter, the the evaluations of the MK courses will be described in detail.

5 THE EVALUATION STAGE OF THE MK COURSES

The evaluation of a course once it has been delivered is seen as a key step in the design, development and delivery process. This step is one which is, in practice, often skimped on or even omitted. Evaluation may use summative assessments to provide data on how well the course as a whole is doing in helping learners achieve learning outcomes. As below, it may also look to see how relevant and effective are the various components built into the course design. In this section the researcher presents evaluation studies of the MK courses that have been designed, developed and delivered following the ten step model shown in figure 3.15, with the particular aim of finding out how effective has been the principled approach to course design that underlies the ten step model.

This part of the study was based on a quantitative and qualitative research design. The various variables affecting students' attitudes and views on their learning process would not simply be revealed from the data collection of questionnaires (quantitative data). Matsuda [105] claims that "drawbacks of the questionnaire include the lack of flexibility to accommodate unexpected issues. Students may also not elaborate as much because they dispense with the written word; these weaknesses were overcome with another data collection method: in-depth interview (p. 79)." In addition, although open-ended responses on questionnaires are regarded as the most elementary form of qualitative data, constraint still exists as Paton [121] indicates, "There are severe limitations to open-ended data collected in writing on questionnaires, limitations related to the writing skills of respondents, the impossibility of probing or extending respondents, and the effort required of the person completing the questionnaire (p. 24)".

Therefore, to explore the respondents and discover students' perceptions of course design, multiple data collection methods were adopted in this part of the study: observation, field note taking, questionnaires, and oral interviews. The researcher's analysis, coding, and interpretations of the data obtained from multiple sources in the field were the primary methods for generating the research findings of this study.

The researcher divided this research process into four parts:

- In part one, data from a short questionnaire used by the Defence Academy for evaluation of the MK courses was analysed.
- In part two, the researcher invited MK students to complete a detailed questionnaire to elicit their thoughts about course design features.
- In part three, the researcher selected six respondents as interviewees for further interviews to get more insight and information from them.
- In part four, the researcher observed subjects engaged in studying some MK lessons.

The four parts of research address the research questions concerning the principles of course design in RBL set out in section 1.3 above.

a. Are students satisfied with this kind of course design?

b. What are students' perceptions of the following features of the course design:

- learning outcomes
- Knowledge map and Lesson maps
- Learning designs using activities
- Lesson assessments
- Summaries

c. What variables affected the perspectives of students on the courses?

d. How did students respond to and interact with the MK courses?

5.1 A short questionnaire evaluation

A short questionnaire is used to gather evaluation data on a regular basis. Here is presented some data from the period May – Aug 06. The questionnaire consists of a mixture of direct 'yes/no' and indirect 'free-text' entry questions. Questions include three sections: (1) course contents, (2) learning designs and (3) summative assessments (see Appendix A).

There were more than 3000 respondents to the questionnaire. All of them had completed the courses MK1 and/or MK2. This evaluation has partly answered the research question that is; "What are students' perceptions of the features of the course design?".

Table 5.1 shows the data regarding course content. It was found that most students were satisfied about the relevance between course content and learning outcomes (94%), the correct difficulty level of content (85%), the accuracy of content (86%) and whether the content was up-to-date (91%).

Table 5.1: Course contents

Questions	No of Respondents	Yes (%)	No (%)
Was the content relevant for the learning outcomes?	3602	94%	6%
Was the content the correct difficulty level?	3604	85%	15%

Was the content accurate?	3605	86%	14%
Was the content up to date?	3592	91%	9%

The second part of the questionnaire, Questions 5-11, was designed to evaluate features of the learning design. The results shown in table 5.2 indicate that there was a flexible learning route in the lessons and also that the signposting was clear and consistent (94%). The majority of students (96%) also regarded the activities as relevant and the activities reinforcing their study and the feedback for the activities were useful. As for the time indicated for the activities, 87% students thought it was accurate. Most of them (93%) were interested in the activities.

Table 5.2: Learning design

Questions	No of Respondents	Yes (%)	No (%)
Did the lessons have a flexible learning route?	3598	94%	6%
Was there clear and consistent signposting of where you were?	3610	94%	6%
Were the activities relevant?	3602	96%	4%
Was the time indicated for the activities accurate?	3590	87%	13%
Did you find the activities interesting?	3586	93%	7%
Did you find the activities reinforcing?	3603	96%	4%
Was the feedback for the activities useful?	3601	96%	4%

Table 5.3 presents the results of learning assessments in the third section of the questionnaire. The data showed 85% of students thought the assessment was an accurate reflection of their knowledge and 88% students regarded the assessment to be of the correct length.

Table 5.3: Summative assessments

Questions	No of Respondents	Yes (%)	No (%)
Was the assessment an accurate reflection of your knowledge?	3599	85%	15%
Was the assessment the correct length?	3522	88%	12%

The results show that the students mostly held a positive attitude toward MK courses and the features of the course design, although free text entries showed there was much concern about the quality of the summative assessment question items. This leads to a major exercise to improve the items. As discussed below, there still remain many concerns about the quality and appropriateness of the summative assessment procedures.

An online questionnaire evaluation

In July of 2008, the researcher distributed an online questionnaire. MK students' views were elicited concerning the course design features employed in the MK courses. The

students were informed that their reflections on the questionnaires would be anonymised. The questionnaire addresses the research questions:

Are students satisfied with this kind of course design?

What are students' perceptions of the features of the course design?

- Advance organizer (Learning outcomes, study times, introductions)
- Knowledge map and Lesson maps
- Learning designs using activities
- Lesson self-assessments
- Summaries

5.1.1 Questionnaire design

The questionnaire (See Appendix B) was developed based on research questions. Most questions were Likert scale .There were also several multiple choice and open answer questions. All of them provided information on respondents' MK learning profiles and their views on the courses. Questions included five sections: (1) respondents' perceptions of learning outcomes of course design; (2) their perceptions of the Knowledge and Task Analysis of the course; (3) their perceptions of the learning design; (4) their perceptions of learning assessments of course design; (5) their perceptions of overall effectiveness of the course design.

a. Pilot Testing and Amendment

Compeau and Higgins[38] recommend that, "A pre-test should be conducted prior to the real data collection phase in order to validate the instrument and correct deficiencies". The comprehension and the average completion time of a questionnaire can be assessed by a pilot test. We handed out three questionnaires to three post graduate students at Cranfield University after the first draft of the questionnaire was drafted. The researcher assessed their completion time and asked them whether they thought the questions were easy to be understood or not. Some details of the questionnaire were amended based on their feedback.

Data Collection

An online questionnaire survey was used as the data collection instrument for this research. There are three reasons to justify why it was appropriate in this case.

- It is online because the desired samples are Internet users and some of them are spread worldwide. Therefore, Internet is the most appropriate medium to reach the sample of students.

- This research requires large quantities of data preferably 150-200 respondents. It is more suitable to use the questionnaire which is predetermined set of questions for eliciting information for every variable to be measured [150] .

- The questionnaire is a valuable tool as it is flexible, relatively fast, accurate and easy to use in statistical analysis [40].

b. Sample Selection

The study is aimed at course design on MK courses to conduct the research. Thus, the population of this study consists of students who are familiar with using MK courses. Criteria for selecting the sample for conducting the survey, is that the sample should have had direct experience in using online MK courses. Harris and Schaubroeck[69] recommend "a minimum sample size of 150 usable questionnaires to guarantee the robustness of a multivariate model".

c. Response rate

The survey lasted for four months starting from October 2008 to February 2009.There were 164 respondents to the questionnaires. Of the 164 completed questionnaires, there were 2 that had some data missing. This left 162 usable questionnaires.

d. Validity

Garson [61] highlights that, "The survey is valid if its measures actually measure what they claim to and if there are no logical errors in drawing conclusions from the data." There were different steps taken to ensure the validity of the study. The literature of the study clearly described the theories that were used for the study. The research questions that were based on those theories had been formulated. Data was collected from both reliable sources, from respondents who are more experienced to using online MK course. Survey questions were designed based on literature review. In order to make sure that the questions can be easily understood, the questionnaires have been pre-tested by the respondents before starting the survey. Therefore, the validity of this research was ensured.

5.1.2 Data analysis and discussion of the survey

This survey mainly took the military officers as the research subjects. After finishing the questionnaire survey completed by these students, the following demographic information and descriptive statistics were gained as shown below.

5.1.2.1 Demographic analysis

As the following figures (5.1 to 5.7) shown, each demographic is: (a) experience with e-learning courses apart from the MK courses; (b) IT skills; (c) at course; (e) the lactation of the study time; (f) the study situation; (g)the study time; (h) The access of the course.

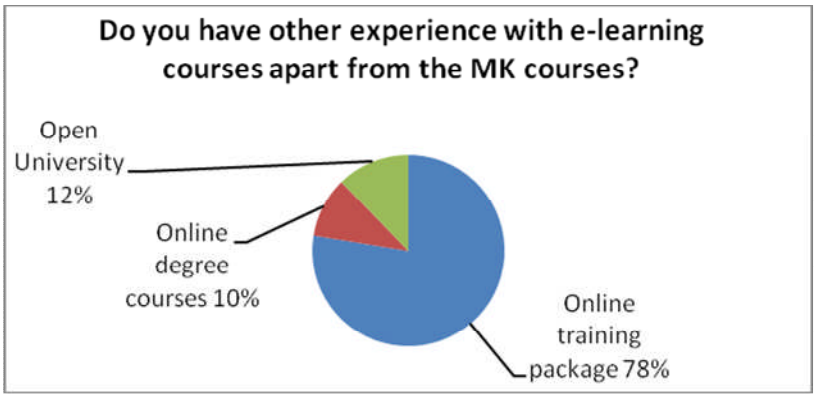


Figure 5.1: The demographic proportions of the respondents' experience with E-learning courses

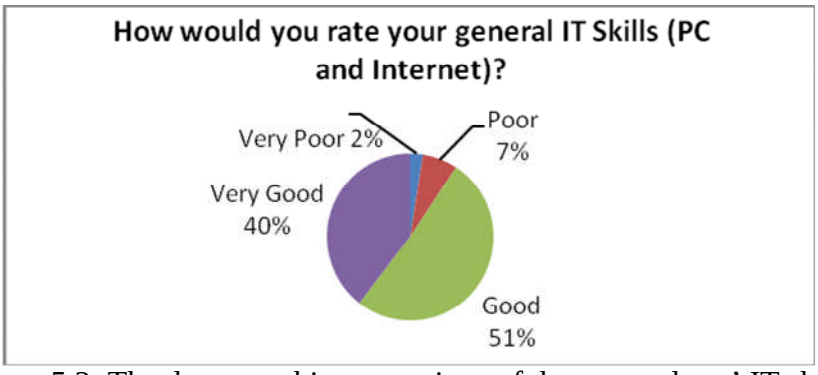


Figure 5.2: The demographic proportions of the respondents' IT skills

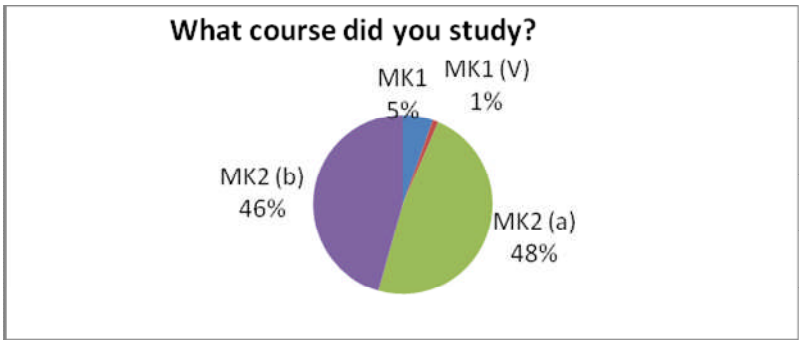


Figure 5.3: The demographic proportions of the courses studied

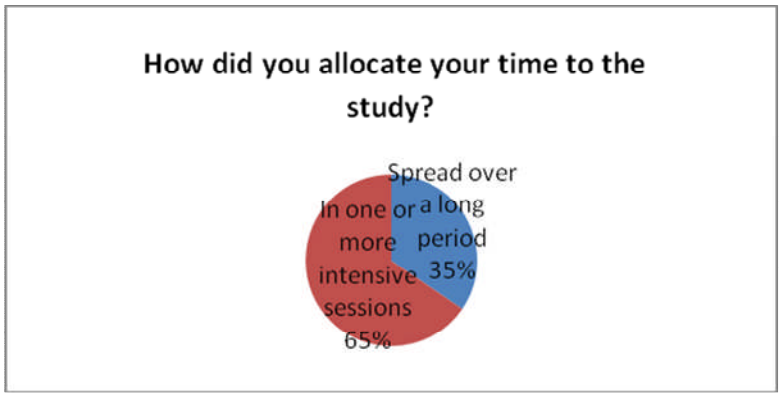


Figure 5.4: The demographic proportion of how the respondents allocated their study time

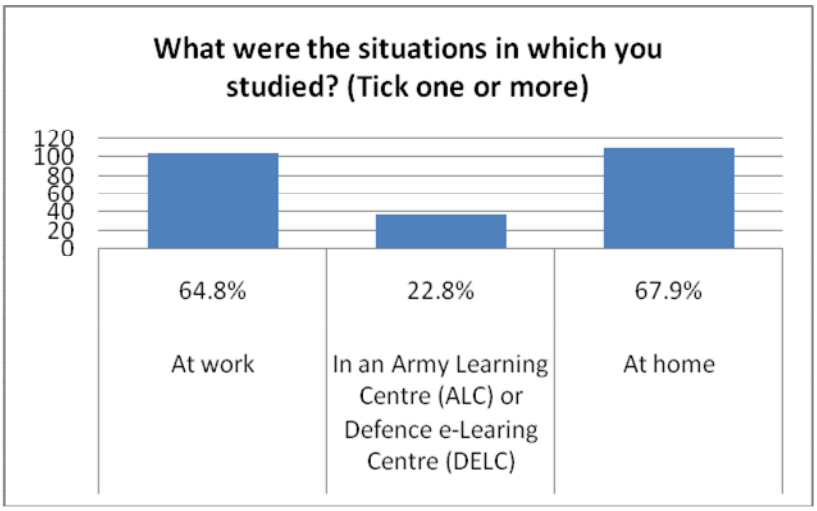


Figure 5.5: The demographic proportion of the respondents' study situations

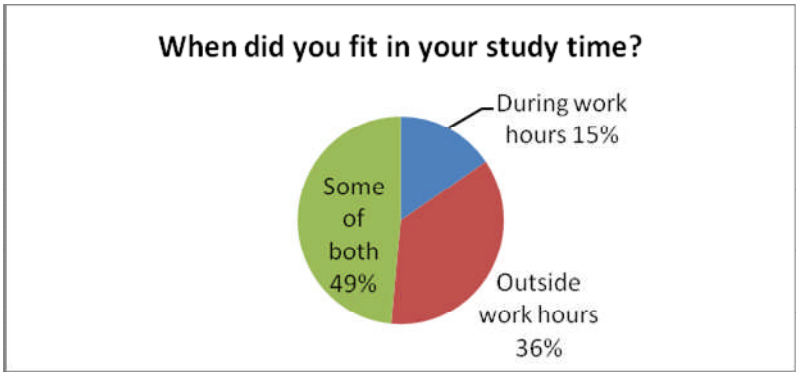


Figure 5.6: The demographic proportions of the respondents' study time

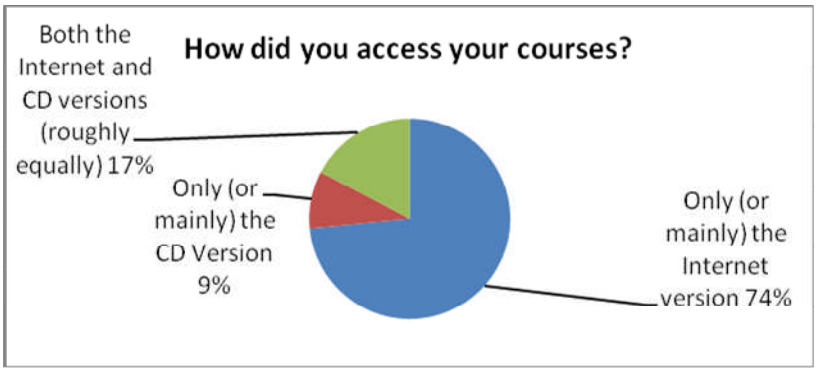


Figure 5.7: demographic proportions of how the respondents access the courses

5.1.2.2 Descriptive statistical analysis for the effectiveness of course design

The result from of the survey is coded to see how the respondents perceive MK courses in terms of its course design. Respondents indicated their level of opinions in different levels. The mean of the response to each Likert scale question was calculated by multiplying the number of respondents for each rating by the rating number adding the results, and then dividing that total by the total number of respondents. The results of the background questionnaire will be presented in the order of the aforementioned four sections.

- **Respondents' perceptions of learning outcomes of course design**

The first section of the questionnaire examined the respondents' perceptions of learning outcomes of course design. The results of specific questions in the questionnaire concerning the design of learning outcomes of course design are presented in Table 5.4.

The means were calculated according to the scores of each selection coded (very useful = 4, useful = 3, a little useful = 2, not useful = 1 and always = 4, frequently = 3, sometimes = 2, rarely = 1).

Table 5.4: Items concerning the content of learning outcomes

Item Number	Items	Mean
1	How useful were the statements of study time?	1.78
2	How useful were the Module Introductions?	2.47
3	How useful were the statements of Learning Outcomes at Module level?	2.17
4	How useful were the statements of Learning Outcomes at Lesson level?	2.31

5	How frequently did you read through the Learning Outcomes before studying a Lesson?	2.34

As can be seen from Table 5.4, Item 1 with a mean of 1.78 (out of a total 4.00) is about the usefulness of the statements of study time. It is lower than the average number (2.00). It seems that most respondents did not agree the statements of study time were useful. After reading the comments of the respondents about this question, the researcher found most respondents thought the statements of study time were not accurate. Here are some comments from the respondents.

"*The statements of study time are woefully inaccurate. I may take that long to read the material once but not to learn sufficient to pass the assessments."*

"Always wrong - too short. Generally not proportional to actual study time."

"Some subjects take far less time & others far more"

"On the early version of MK2, the study time statements were exceedingly inaccurate. (For Module A it took me over 7 hours pure study, against a predicted 6, and with note-making and revision, this went up to 21 hours.) Since Nov 07 it seems to be more on track, but I haven't revised (or been assessed) on any of the modules yet."

It seems that most respondents who agreed that Module Introductions were useful (mean = 2.47, out of total 4.00). But there were few respondents thought they were not useful. Here are a couple of comments from the respondents who had negative opinions about the Module Introductions.

"I always skipped them"

"Had so much to do that I didn't bother reading them."

It also seems that most respondents agreed that the learning outcomes of Module level (Item 3) and Lesson level (Item 4) had been useful before they started the lessons (mean = 2.17 and mean = 2.31, out of total 4.00). One of the respondents commented that "*Good summary to use as a checklist for learning.*"

Item 5, concerning the usage of learning outcomes by respondents (mean = 2.34, out of a total 4.00), shows that respondents quite often use the learning outcomes before studying a lesson. Some respondents gave very positive feedbacks about this question.

"It was a good indication of what was to be studied and where the information could be found."

"Sets the tone for the learning package"

All in all, most scores are higher than the average (above 2.00) for this part, which suggests that overall the respondents' perception of the design and usefulness of the learning outcomes were positive.

- **Respondents' perceptions of Knowledge and Task Analysis of course design**

The results of specific questions (items 3 to 8) in the questionnaire concern the Knowledge and Task Analysis of the course design. They are presented in Table 5.5 and Table 5.6. The questions of this part are of the Likert scale and multiple choice questions. The mean was calculated according to the score of each selection coded (very useful = 4, useful = 3, a little useful = 2 and not useful at all = 1).

Table 5.5: Items concerning the knowledge and task analysis and navigation

Item number	Items	Mean
1	How useful was the knowledge map for helping you understand the structure of the course?	1.86
2	How useful was the knowledge map for helping you navigate through the course?	1.89
3	How useful was the lesson map for helping you understand the structure of a lesson?	2.03
4	How useful were the lesson maps for helping you navigate through a lesson?	2.08
5	How useful was the topic navigation bar at the top of the screen?	2.63

As can be seen from table 5.5, Items 1 and 2 are about the usefulness of the knowledge map and got the means of 1.86 and 1.89 (out of a total 4.00). It seems that almost half the students did not agree that the knowledge map had been useful for helping them understand the structure of the course or by helping them navigate through the course. After analysing the students' comments about these two questions, the researcher found two main reasons that hindered respondents in using the knowledge map. One was the size of knowledge map was too big and unable to be seen clearly on one computer screen. The other was that there were some respondents who preferred to study step by step. This meant that they did not need to use the knowledge map to help them understand the structure of the course and to navigate the course. Here are some comments from those respondents.

> *"Useful to get a scale of it but useless as it will not fit on one screen or print on one page."*

> *"It is too big a document unless you print it off at A3."*

"Never used it. I just went through lesson by lesson and module by module."

"I did not refer to the Knowledge Map"

"I simply went through the course in chronological order."

Items 3 and 4 concern the usefulness of the lesson map for understanding the structure of a lesson (mean = 2.03) and for helping respondents navigate through a lesson (mean = 2.08). This suggests that just above half the respondents had positive opinions about them. The main reason for those respondents who thought the lesson map was not useful is that they did not notice that the Lesson Maps were available, this despite the fact that they are described in the course Study Guide and demonstrated in an interactive sample lesson.

Item 5 is about the usefulness of the topic navigation bar. The mean is 2.63 which suggests that most respondents regarded the topic navigation bar as useful. Here are some positive comments are from respondents.

"Good for switching back and forth if required."

"Excellent for revision before completion"

"Acted like a book mark for me."

"The easiest way to navigate through"

But there are some respondents did not think it was useful. The reason is that they did not notice it.

The items of Table 5.6 concern the learning styles of the respondents. In this research, we divided the learning styles of respondents into two main categories according to CT. One is serialist learners and the other is holist learners. Serialist learners like to learn step by step. Holist learners prefer a more holistic approach, based on wishing to know how a course is organised as a whole before embarking on detailed learning.

Table 5.6: Items concerning the respondents' learning styles

Item 1 Which description best fits how you navigated through the course. (Tick one or more)	
Answers	Percentage of Total No
1. I worked through the lessons in sequential order.	84.3%
2. I worked on lessons in which I was interested and filled in gap lessons.	5.9%
3. I first worked on a lesson where I was unsure of	3.3%

the content. 4. I first worked on the lessons where I already knew something.	 11.1%
Item 2 Which description best fits how you worked through the lessons? (Tick one or more)	
Answers	Percentage of Total No
1. I worked sequentially through the topics.	87.5%
2. I moved between topics to check my understanding.	15.1%

As can be seen from the above Table, most respondents were serialist leaners who worked through the lessons and topics in sequential order. This result may explain why many respondents did not use the Knowledge Map and the lesson maps.

- **Respondents' perceptions of learning design**

This section of the questionnaire examined the responses' perceptions of learning design. The results of specific questions are in Table 5.7. The means were calculated according to the scores of each selection coded (Almost always = 4, mostly = 3, sometimes = 2 and rarely = 1). Item 1 and 2, are about the online summaries (mean = 2.64) and the printed summaries (mean = 2.90). It seems that respondents mostly used both summaries to check their understanding. One student had commented that "*The lesson summaries are the best part of the Mk2 package and assist the most with learning.*" Particularly, the respondents more prefer to use the printed summaries. Here are some comments from the respondents about the printed summaries.

> *"The printed lesson summaries also make a good revision tool, alongside my own notes."*
>
> *"I find the printed word easier to read and learn from so made use of this aspect of the course"*
>
> *"The lesson summaries are the best part of the Mk2 package and assist the most with learning."*

Item 3 concerns the lesson activities (mean = 3.24), indicates that respondents always worked through them. Here are some comments from the respondents.

> *"Very useful in pulling together information."*
>
> *"These generally led to the questions in the lesson assessments"*
>
> *"Keen to use all tools to ensure understanding of topic"*
>
> *"Often seeking the answer so that could move on to the other topics."*

Item 4 is about the lesson self-assessment questions (mean = 2.89), suggests that most respondents thought they were useful. Here are some comments from the respondents.

"These let me know if I needed to revise something again"

"They gave a clear focus on the key element of the subject."

"Made full use and they ultimately assisted in the learning process."

Items 5 and 6 are concerned with the multimedia design of the course. More than half the respondents liked to use the animated graphics (mean = 2.53) and the embedded hypertext items with icon 'i' (mean = 2.54). They used them to aid their understanding of the course. Here are a couple of comments.

"The animation helped put the text into context; it certainly helped me to understand the processes better. A picture paints a thousand words"

"Made the process much more 'human' especially when studying alone."

Table 5.7: Items concerning the content of learning design

Item number	Items	Mean
1	How frequently did you use the online summaries to check your understanding?	2.64
2	How frequently did you use the printed lesson summaries to check your understanding?	2.90
3	How frequently did you work through the lesson activities	3.24
4	How useful were the lesson assessment questions?	2.89
5	How useful were the animated graphics as aids to understanding?	2.53
6	How useful were the embedded hypertext items with icon 'i' as aids to understanding?	2.54

- **Respondents' perceptions of the summative assessments of course design**

The results of specific questions in the questionnaire concern the summative assessments of course design. They are presented in Table 5.8. All the questions of this part are Likert scale questions. The mean was calculated according to the score of each selection coded (Very easy = 4, easy = 3, difficult = 2, very difficult = 1 and very good = 4, good = 3, poor = 2, very poor = 1).

Table 5.8: Items concerning the summative assessments

Item	Items	Mean

number		
1	How easy to follow were the module assessment procedures	3.09
2	How would you rate the quality of the questions in the module assessments?	2.81

The data for Item 1, about how easy to follow were the summative assessment procedures (mean = 3.09), suggests that respondents mostly felt they were easy to follow. Item 2 concerns the quality of assessments questions (mean = 2.81), indicating that the quality of the questions was generally perceived as being good. Earlier iterations of the MK courses were criticised for the poor quality of the summative assessment items, so this is good news for the course developers.

- **Respondents' perceptions of overall course design**

Items 1 and 2 investigate overall effectiveness of the course design as shown in table 5.9. The mean was calculated according to the score of each selection coded (strongly agree = 4, agree = 3, disagree = 2 and strongly disagree = 1).

Table 5.9: Item concerning the overall effectiveness

Item number	Items	Mean
1	Working through the MK courses has helped me become a more efficient and effective learner	1.97
2	I would be happy to do more studying by online distance learning.	2.21

Item 1 is about the effectiveness on the respondents' study (mean = 1.97). This suggests that almost half the respondents did not perceive and agree that they had become more efficient and effective learners after working through the MK courses. After checking the comments of this question, the researcher found that the respondents prefer more of a blend of learning styles. As one student mentioned, *I found e-learning to be effective only in conjunction with paper notes*.

In sum, respondents' responses from the questionnaire were analysed concerning aspects of the course design and the overall effectiveness of the course design. The results showed that respondents mostly held positive attitudes toward MK courses and its course design features. Therefore, the two research questions of course design are well-supported. Respondents in general perceived MK courses positively. They are satisfied with this kind of course design. Respondents held a positive attitude toward the features of the course design, which are advance organisers (instructions, learning outcomes, topic lists and lesson introductions), statements of study time, the Knowledge Map and lesson maps, learning designs using activities, lesson self-assessments and summaries

5.2 Student interviews

To elicit more in-depth information about students' perceptions of the course design features, semi-standardised, open-ended oral interviews were conducted between May of 2008 and October of 2008. There were in total six respondents that participated in this part of the study. The interviews were arranged in their spare time and took place in the researcher's office. Each individual interview took from about one and half hours to two hours. Each respondent was asked to read the instructions and sign the letter of consent before the interview started (See Appendix C.)

Since the purpose of the in-depth interview was to reveal respondents' own viewpoints about the MK courses, an informal conversation was conducted. The respondents were guided by many descriptive questions to help them feel comfortable and to address their perceptions spontaneously. All interviews were audio recorded with the respondents' permission and ethnographic notes were taken by the researcher at the same time. The final tasks for data collection were to transcribe the recorded interviews and to expand the condensed notes taken during the interview [148](p. 91).

After collecting the data concerning respondents' statements regarding their perceptions and perspectives on their learning experience of the MK courses, the "constant comparative method" of grounded theory [22] was then used to analyse all the written scripts and recorded transcripts. This was carried out in order to identify the repetitions in perceptions among the respondents and to see what major themes might emerge to help interpret and explain the perspectives of the MK learners.

5.2.1 Interview protocol

A general guide approach as described by Patton [121] allows more flexibility than pre-designed questions. An interview protocol was prepared beforehand to cover crucial issues regarding respondents' perceptions of and attitudes towards the MK courses and to effectively control interview time. .

The exploratory questions constructed in the form of an interview protocol were based on the research questions to find out how the course design features of the MK courses. The exploratory questions in the interview protocol (see figure 5.8 and Appendix D) addressed the following research questions aforementioned:

What variables affect the perspectives of MK learners?

What are respondents' perceptions of the features of the course design?

- Learning outcomes
- Knowledge Map and lesson maps
- Learning designs using activities
- Lesson assessments
- Summaries

Question1 asked for the participant's overall impressions about the MK course and the circumstance in which they studied.
Question 2 asked for comments regarding the menus of the Bb course.
Question 3 sought to explore how useful were the statements of study time in the study guide.
Question 4 sought to examine how the respondents used the Knowledge Map.
Question 5 asked for respondents' perceptions of the statements of learning outcomes.
Question 6 asked for respondents' perceptions of the lesson maps and the topic navigation bar.
Question 7 sought to explore what kind of learning strategies respondents used.
Question 8 asked for respondents' perceptions of the animated graphics and hypertext items.
Question 9, 10, 11 and 12 asked for participants' perceptions of summaries, activities, lesson self-assessments and summative assessments.
Question 13 sought to examine the overall satisfaction of respondents with respect to course structure, content, navigation and assessments.
Question 14 asked for an illustration of the respondents' perception and beliefs on what could be done to improve MK courses with regard to structure, content, navigation and assessments.
Question 15 sought to explore whether respondents were positive or negative about their experiences of being MK learners.

5.2.2 Presentation of the interview data

The purpose of this section is to present the interview data gathered from the six respondents, randomly selected from the MK students who had participated in the study. Their responses were gathered as interview data, which was then processed and organised and presented in tables to provide the reader with a succinct overview of individual and group responses.

The interview data was collected from various information resources, such as respondents' demographic information sheet, field notes taken by the researcher during the interview, the transcription of the overall interviews which were audio recorded and video recorded. The information collection and analysis tasks processed simultaneously to help the researcher think of meaningful ways to deal with the vast array of information presented from the field. All the interview data was managed by way of constant rearrangement and comparisons to analyse and synthesise them into major elements and categories according to themes and main concepts.

Results are presented using a number of tables to give the reader an overview of respondents' responses together with direct quotations from each interview question. Direct quotations are used to assist the reader in assessing whether the researcher used the data appropriately to support the conclusions.

5.2.2.1 Description of the respondents selected for the study

The respondents taking part in the study were all military officers. The time period was from October, 2007 to March, 2008. Each interview lasted for at least one and half hours. After the interviews the researcher asked the interviewee for his e-mail and contact number in order to respond to any questions that arose afterwards.

The demographic information of the six respondents is shown in Table 5.10.

Table 5.10: The background information of the six respondents

No	Gender	e-learning experience	IT Skills	Course	Interview Date
I	Male	None	Intermediate	MK1	17/10/07
II	Male	None	High	MK1	18/10/07
III	Male	None	Intermediate	MK2	31/01/08
IV	Male	None	Intermediate	MK2	06/02/08
V	Male	A little	High	MK2	11/02/08
VI	Male	None	Intermediate	MK1	23/02/08

5.2.2.2 Summary and analysis of data

All the responses of the respondents to the exploratory questions have been presented into categories shown in the tables below by the constant comparison analysis method.

After describing the categories induced from the raw interview data of the individual participant's responses to each guided question, the researcher then tried to explain and analyse the categories of respondents for each interview question. The major components within the framework of exploratory questions shown in Figure 5.8 would be explained and analysed thoroughly and clearly. According to Patton [121], two strategies are suggested to analyse interview data. One is case analysis for each person interviewed or each unit studied while the other is cross-case analysis. Patton [121] states that, "Cross-case analysis means grouping together answers from different people to common questions or analysing different perspectives on central issues."

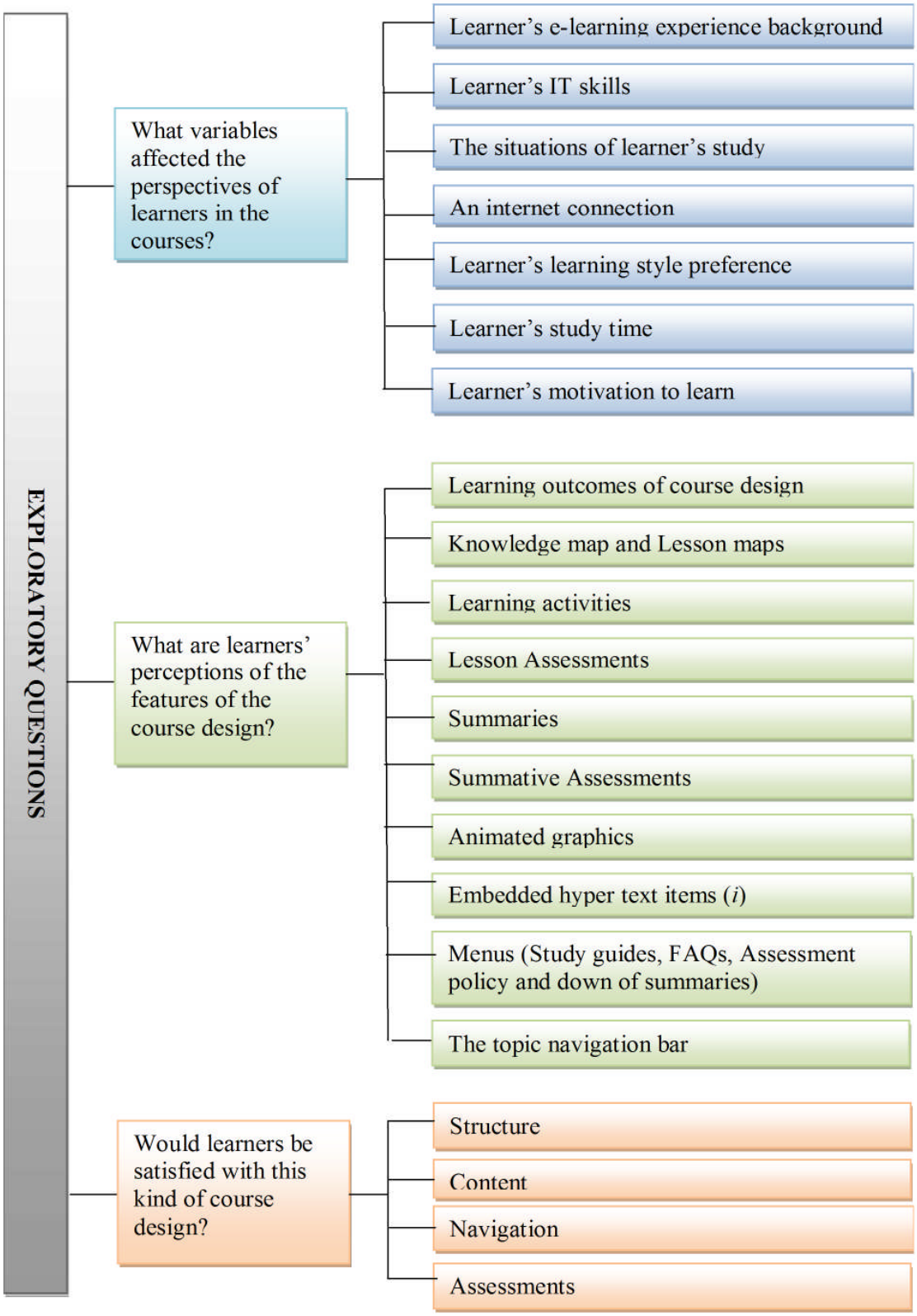


Figure 5.8: Major components within the framework of exploratory questions

The perspectives of the MK learners

Table 5.11 shows the responses of the respondents to question 1: "**Tell me about your overall learning situations for the MK courses**?" These were summarised and presented according to the categories generated from the data by the inductive method. This question also answers the research question "What variables affect the perspectives of MK learners?"

As shown in Table 5.11, none of the respondents had any e-learning experiences before they studied MK and it was the first time for them to experience e-learning. One appreciates that it can take time for them to get used to a new learning environment. The majority of them thought they had intermediate or high level of IT skills and had no problems using the MK courses from a technical point of view.

From the situations experienced in their study, we can see most of them felt the MK courses to be flexible and convenient to use, one reason being that they could study at different places, for example, home, work and The IT centre. Also they felt there were many distractions. As participant II expressed his learning experience as follows:
"I had no time to study MK at work so I had to study at home during evenings and weekends. I tried to find a big chunk of time to carry out the study. But it was impossible. When I studied at home, my children messed up the table and asked me to play with them. I tried to study in the night when I could concentrate on the study, but I was so tired."

All of them indicated that their study time was flexible, but they felt too tired to sit in front of the computer for long periods after their busy work during the day. They also mentioned that the two versions of MK (VLE and CD) were good. When they were unable to access an internet connection, they could use the CD version. It was very interesting to find out that all respondents learning motivations were tied in with their aspirations regarding their grades. They were willing to do MK courses since they wanted to have good grades and hence to get future promotions. But they felt frustrated because they could not share ideas with their peers and tutors; also they felt isolated during the study. From this perspective, they would rather study in a lecture room with other students.

Table 5.11: Tell me about your overall learning experience with the MK courses.

Categories	Respondents	Respondents
A e-learning experience	None	I, II, III, IV,VI
B IT skills	1.High	II, V
	2. Intermediate	I,III, IV,VI
C Situations of study	1. Home	II,III,IV,V,VI
	2. Workplace	I,III
	3. IT Centre	I, III,V
	Positive View:	
	More flexible and	I,II,III,IV,V,VI

	convenient Negative View: 1. Lots of distractions during the study and could not concentrate on the course completely. 2. No peer cooperation	 II, III,IV I,II,III,IV
D An internet connection	No Yes	I II,III,IV,V,VI
E Learner's learning style preference	Worked through the course and lessons in a sequential order	I, II, III, IV,V,VI
F Learner's study time	1.Work time 2. Off work time Positive View: Study time is flexible Negative View: 1. The time was not enough because of busy work. 2. Felt too tired to study after the busy work	I,V II,III,IV,VI I,II,III,IV,VI II,III,IV II, IV,V
G VLE or CD	1.VLE 2.CD Positive View: Both versions are convenient for study.	II,III,IV I, II,III,IV I,II,III,IV
H Learner's motivation to learn	Positive View: Willing to study for better grade Negative View: Not feeling increasing motivation to learn since is better to share ideas with peers and tutor.	 I,II,III,IV,V,VI I,II,III,IV,V,VI

Overall impressions about the MK courses and the circumstances

Table 5.12 shows the responses of respondents to the question: "What are some of your overall impressions about the MK courses?"

Table 5.12: Overall impressions

Categories	Respondents	Respondents
A Teaching material	Positive Views: Provided with enough and good comprehensible content. Negative Views: 1. Not relevant for student's present job. 2. Should be taught in classrooms.	 I,II,III,IV,V,VI I,IV,V,VI II,III,IV
B Learning efficiency	Positive Views: Can get to the point of each lesson easily Negative Views: It is difficult to remember the content.	 III,V,VI I,II,III,IV

As was shown in Table 5.12, respondents illustrated a couple of issues that need to be addressed regarding MK courses when asked about their overall impressions of MK. All of them indicated that the teaching materials were good and had enough content. Some of them thought the knowledge was not relevant with their present jobs. They could not see why they needed to learn this knowledge.

For example, Participant II comments:

> *"I couldn't see why I had to learn it. That is not to say that I disagreed with why I was being forced to learn it, because I appreciated that at that stage in my career I didn't know all..., I couldn't relate to why it got into the terms of defence policy and finance and so on... I could not understand, because it was nothing to do with my background."*

Some of the respondents mentioned that they preferred to study in a classroom environment. As Participant I noted:

> *"The knowledge provided by MK is good, I do not necessarily agree that distance learning is useful for this subject matter. Because military knowledge is changing all the time, it is good to be taught in a classroom where students can interact with each other's experience and about this knowledge."*

The other finding from the respondents' responses was about learning efficiency. They felt it was easy to get the points of the knowledge from what they were studying but that the knowledge they had learned did not stay in their memory for long afterwards. They could not remember some knowledge after they had finished the MK course.

Table 5.13: The features of Mk course design

Categories	Respondents	Respondents
Menu	Positive Views: Very useful	 I,II,III,IV,V,VI
Study guide(s)	Positive Views: Useful	 I,II,III,IV,V,VI
FAQs	Positive Views: Useful	 I,II,III,IV
Assessment Policy	Positive Views: Useful and clear	 I,II,III,IV,V,VI
Statements of study time	Positive Views: Useful	I,II,III,IV,V,VI
Download of summaries	Positive Views: Very useful	 I,II,III, IV
Knowledge Map	Positive Views: 1.A little useful for helping understand the structure of the course 2. A little useful for helping navigate through the course Negative Views: 1.Not useful 2. Not printable	 I,III, IV I,III V, VI I,II,III,IV,V,VI
Introduction	Positive Views: Useful Negative Views: Not useful	 II,III,IV I,V,VI
Learning Outcomes	Positive Views: 1. It was very helpful to have learning outcomes specified down at the level of individual lessons. 2. Always read through the learning outcomes before studying a lesson.	 I,II,III,IV,V,VI I,II,III,IV,V,VI
Lesson Map	Positive Views: If it had been known about by the respondents, 1. It would have been very useful for helping	 I,III,IV

	understand the structure of a lesson. 2. It would have been very helpful for helping navigate through a lesson. Negative Views: Was not seen during the study of the lessons	 II,V,VI
Topic navigation bar	Positive View: Very useful	 I,II,III,IV,V,VI
Animated graphics	Positive View: Useful Negative View: Not useful	 II,III,IV I,V,VI
Hypertext items(i)	Positive View: Useful	 I,II,III,IV,V,VI
Summaries	Positive View: 1. Always used them to check understanding 2. Always used the printed lesson summaries to check understanding Negative View: Not useful	 II,III,IV,V,VI II,III,IV I
Activities	Positive View: Often worked through them Negative View: A waste of time	 II,III,IV,V,VI I
Lesson self-assessments	Positive View: 1.Useful 2. Often worked through them	 I,II,III,IV II,III,IV,V,VI
Summative assessment	Positive View: 1. Procedures are useful 2. Questions are relevant Negative View: 1.Questions are poor quality 2. Some answers are wrong	 I,II,III,IV,V,VI I,II,III,IV,V,VI I,II,III V

Table 5.13 shows the respondents' perception of the features of MK. There are some interesting findings from these respondents' points of view on the course design of MK. All of them had a positive view of the topic menu, study guides, FAQs, assessment policy, statements of study time, learning outcomes, topic navigation bar and hypertext items. Especially they also mentioned that being able to download the summaries was very useful for their study. As respondent III comments,

> *"I printed them out and put them in a folder. I made notes on them. I used them to review my study. If I found I was not sure of some knowledge, I highlighted them. I would go back to them again."*

As for the Knowledge Map, they had different opinions. Most of them thought the Knowledge Map was useful to help them understand the structure of the course and help them navigate the course.

As respondent I notes,

> *"I found the Knowledge Map very good in helping me to navigate the course. I often checked it to see where I was in the course. Because it was not convenient to look at the whole map when I used Bb and the CD, I printed out the whole map by parts and connected them together. I put the whole map on the wall, so I would not get lost when I studied"*

But some of them thought the Knowledge Map is not useful. As respondents IV comments,

> *"Here you have the Knowledge Map which tells you where the things were. But I found it was quite difficult to navigate to a particular topic. If I needed to get somewhere to remind myself, I could not do that."*

Another interesting finding was about the lesson maps. None of the respondents dsaw the button which is the link to the lesson map. They did not use the lesson map during their study at all. But after the researcher told them about the function of the lesson map, all of them thought it would have been useful to help them understand the structure of a lesson and help them navigate to the topics.

As for the multimedia features of the course, such as animated graphics and activities, most respondents thought they were useful to help them understand the knowledge. However one of the respondents preferred the static text and got the points of knowledge straight away.

The MK summative assessments seemed a big issue from the responses of the respondents. All of them thought the procedures of the assessments were good and the questions were relevant to the knowledge they had learned. But they also thought the many questions were of poor quality and some answers were even incorrect.

As participant III comments,

"I knew some answers were wrong, so I had to answer wrongly to get the points. People had to learn the incorrect knowledge to pass the test."

Participant II notes,

"*Some questions are stressful. I had to fill in the exact words. If I gave a word wrong, then I could not get the points. But if there is a human teacher marking the answers, I could have got 80% of the point across of the answer. It was not flexible."*

Table 5.14: Learning satisfactions of studying MK

Categories	Respondents	Respondents
Structure	Positive View: Good	 I,II,III,IV,V,VI
Content	Positive View: Good Negative View: 1. Some contents were not relevant for the present jobs 2. Some MK2 contents are repeated in the ICSC course. 3. MK2 offers too much information	I,III,IV II,V IV,VI IV
Navigation	Positive View: Good Negative View: Search box should be provided	I,II,III,V,VI IV
Assessments	Negative View: The quality of the questions was poor.	 I,II,III,IV,V,VI

Table 5.14 summarises the responses to the questions: "What were the things (if any) that you liked about the courses? And what were the things (if any) that you disliked about the courses?"

It was interesting to find out that most respondents perceived the structure, contents and the navigation of the courses as good in general. In terms of the navigation of the courses, respondent IV eloquently expressed his opinions as follows:
"*It has been frustrating to try to find a specific point quickly. It will be ideal if there is a search box which one can input keywords to search for the information."*

None of them felt the quality of the questions of summative assessments was good. As mentioned before some questions need exact phrases to match the answers. They felt it was stressful to answer those questions.

Suggestions for improvements of the MK courses

A question was presented to elicit the respondents' beliefs with regard to creating a successful MK course design. Table 5.15 summarises the responses of the respondents when they were asked the question: "**In what way do you think the course could be improved?**" The table was drawn up in a form that depicts the perspectives of all respondents concerning improvements to the MK course design.

Participant III talked of his opinions on how MK course design could be improved. He explains:

> "*I felt MK just simply downloaded the information to the human brain. It was just interaction with a screen. I could not remember 5% of the knowledge that I had learned after I passed the MK. If I had discussions with other students and challenged each other's thoughts then I found I could remember more knowledge."*

Table 5.15: What features help you describe an ideal MK course design?

Participant	Response
I	1. Respondents are provided with a chance for group discussion and better interaction. 2. A learning environment that lowers the learner's learning anxiety and increases learning motivation.
II	1. Good learning navigation. 2. Feedbacks and learning aids are provided. 3. Assessments could be fairer.
III	1. Prefer classroom environments. 2. Have discussions with peers and tutors. 3. Knowledge should be updated every six months.
IV	1. Put the courses into classrooms. 2. Reduce the content while keeping necessary content. 3. Assessments to be fairer.
V	1. Good quality of the assessment. 2. Interesting learning activities
VI	1. Collaborative learning environments. 2. Instant feedbacks of learning activities.

Eventually, a 'SWOTS' analysis was constructed. The most common method of strategic analysis is SWOT, which stands for "the strengths, weaknesses, opportunities,

and threats of the environment"[72]. Strengths and weaknesses emphasize the understanding and analysis of inner conditions, while opportunities and threats are concerned with the degree to which the outside environment has an effect. The added part of "strategies" was presented to give the researcher some suggestions regarding the MK courses. The results of the SWOTS analysis are shown in Table 5.16.

Table 5.16: The SWOTS analysis of the MK courses

Elements	Related dimension of the MK courses
Strengths	1. Learner oriented 2. Flexible access to the courses 3. Students decide individually about the sequence and pacing of learning 4. Students like to use learning outcomes to preview their knowledge 5. Good structure 6. Good navigation 7. Good learning activities 8. Students appreciate checking their knowledge using lesson summaries. 9. Students appreciate testing their knowledge using self-assessment quizzes 10. Visualization (graphics, animation)
Weaknesses	1. Lack of opportunities for collaborative learning 2. Study times often underestimate what is required 3. Screen-handling is exhausting 4. Quality of summative assessment questions could be better 5. Students need to be quite well motivated 6. A 'self-management' culture is difficult for some students 7. Some students would prefer blended approaches that include off-line study 8. Loss of face-to-face richness
Opportunities	1. More flexible access to learning 2. Can reach more students over a range of times and locations
Threats	1. Influence of traditional teaching approaches 2. Lower motivation 3. Drawbacks of using technology (need for training, access, accessibility)
Strategies	1. To update the content 2. To further improve the quality of summative assessment questions 3. To provide opportunities for collaborative learning 4. To employ intelligent tutoring /adaptive teaching 5. To develop more sophisticated ways of assessing understanding, e.g., games and tasks based on scenarios

5.3 The Observation Study

Pawar [122] states that, "The observation method helps to overcome some of the limitations of other data collecting methods such as interview, questionnaire and focus group discussion. The method helps collect rich and insightful data in natural settings with relatively less cost and less inconvenience to the researcher (p. 18). In a natural environment, observation can see through something that others cannot reach." Furthermore, Pawar [122] states that observation is composed of not just "visually noticing", but also "interpretation and meaningful construction" (p. 19).

In order to answer the research question 1 of "**How do students respond to and interact with the course during the learning process**?" Observational studies were carried out with six subjects. The subjects were in a similar age range to the MK students but none had prior knowledge of the course contents. Each session lasted around fifty minutes in every week from April 2008 to July 2008. Each respondent was asked to read the instructions and sign the letter of consent before the observational study started (see Appendix E).The researcher recorded the respondents' behaviours during the learning by audio and video. On finishing each observation study, the researcher transcribed the data from audio and video recording and filed notes into texts for data analysis.

Respondents' interaction with the MK course will be discussed in terms of their learning activities while studying. Seven lessons were chosen from MK1. Respondents took a summative test at the end of their studying. Nineteen learning activities (Table 5.17) were distinguished and observed.

Table 5.17: Learning activities

Activity	1. Reading study guide
	2. Working on interactive study guide
	3. Checking knowledge map
	4. Checking glossary
	5. Reading module introduction
	6. Reading learning outcomes of the lesson
	7. Reading section introduction
	8. Reading lesson introduction
	9. Checking lesson map
	10. Using the forward button
	11. Using the backward button
	12. Using the topic navigation bar
	13. Reading the animated graphics
	14. Checking the icon 'i'
	15. Working on the lesson activities
	16. Reading the feedback of the lesson activities
	17. Reading lesson summary
	18. Working on the lesson self-assessment
	19. Checking the feedback on the lesson self-assessments

The navigation behaviours of the respondents, including their use of these nineteen activities in studying the topics of the different lessons, were tracked. The number of

times each activity was carried out was recorded. The following section starts with the distribution patterns of the 19 activities. After that, the results of summative assessment on each student are presented and discussed.

5.3.1 Frequency of activity use

The results for each student of use of each activity in MK study are shown in Table 5.18.

Table 5.18: The activities used by each student in studying the seven lessons of MK1

Activity	Student I		Student II		Student III		Student IV		Student V		Student VI	
	F	%	F	%	F	%	F	%	F	%	F	%
1. Reading study guide	1	0.5	1	0.51	1	0.53	1	0.52	1	0.5	1	0.6
2. Working on interactive study guide	1	0.5	1	0.51	1	0.53	1	0.52	1	0.5	1	0.6
3. Checking knowledge map	1	0.5	1	0.51	1	0.53	1	0.52	1	0.5	1	0.6
4. Checking glossary	2	0.98	1	0.51	1	0.53	3	1.56	1	0.5	0	0
5. Reading module introduction	1	0.5	1	0.51	1	0.53	1	0.52	1	0.5	3	1.66
6. Reading learning outcomes of the lesson	7	3.42	7	3.57	7	3.74	7	3.65	7	3.3	7	3.91
7. Reading section introduction	1	0.5	3	1.53	0	0	1	0.52	1	0.5	1	0.6
8. Reading lesson introduction	7	3.42	7	3.57	7	3.74	7	3.65	7	3.3	7	3.91
9. Checking lesson map	1	0.5	1	0.51	1	0.53	1	0.52	1	0.5	2	1.12
10. Using the button of forward	52	25.38	48	24.5	43	23	39	20.31	54	25.47	36	20.11
11. Using the button of backward	15	7.45	12	6.12	11	5.88	5	2.6	9	4.25	6	3.35
12. Using the topic navigation bar	6	2.94	5	2.55	5	2.67	7	3.65	5	2.36	7	3.91
13. Reading the animated graphics	28	13.76	30	15.31	26	13.9	31	16.15	33	15.57	29	16.2
14. Checking the icon ‘i’	4	1.96	5	2.55	7	3.74	4	2.08	5	2.36	3	1.66
15. Working	28	13.66	26	13.27	27	14.44	31	16.15	32	15.09	27	15.08

The percentage of activity use shown in Table 5.18 was calculated by dividing the number of times respondents did a particular activity by the total number of times respondents used activities.

In studying the seven lessons, all six respondents used the ‘forward’ button most frequently, with reading the animated graphics, working on the lesson activities and reading the feedback of the lesson activities coming in a distant second. Using the ‘backward’ came third. Reading learning outcomes of the lesson, reading lesson introductions, reading lesson summaries, working on lesson assessments and checking the feedbacks of the lesson assessments came in a distant fourth, Checking the icon ‘i’ was fifth, and reading the study guide and working on interactive study guide, checking the knowledge map, checking the glossary, reading the module introduction and checking the lesson map came in last. This is illustrated in the graphic presentation in Figure 5.9.

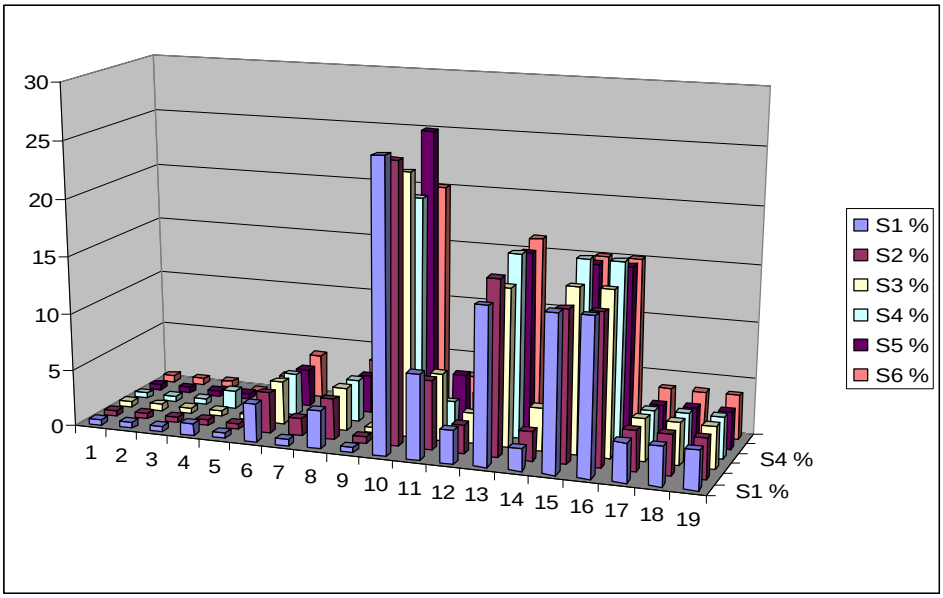


Figure 5.9: Distribution of fifteen activities used by six respondents

When the researcher further examined individual activities usage among the six respondents, it was found that the difference was not much in usage of these 19 activities. Figure 5.10 presents the difference between six respondents on individual activities usage.

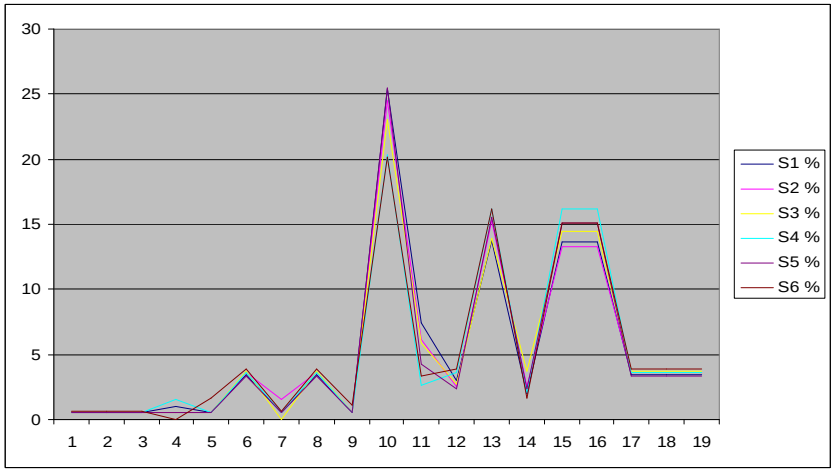


Figure 5.10: Percentages of individual activities usage of the six respondents

In summary, as the results found in the previous figures illustrate, the researcher classified six interactive patterns that most commonly occurred in the interactions between respondents and the courses during MK learning. These not only featured the basic principles of course design but also facilitated their learning. These patterns used navigation buttons, learning outcomes clarification, reading the animated graphics, working through lesson activities and feedbacks of lesson activities, summaries and lesson assessments.

- Navigation Buttons Use of

Navigation buttons usage was one of the most distinctive features in MK courses. All respondents used the forward and backward buttons to navigate the course.

- Learning Outcomes Clarification

Based on the observational data, the researcher found that respondents read the learning outcomes before they started a lesson.

- The Animated Graphics Use of

Most respondents checked the animated graphics whilst they studied topics. They looked through the contents of the graphics.

- Learning Activities

All the respondents tried to work on the learning activities of the lesson they were learning. If they got wrong answers from the feedback, they would then work through the topic they were not comfortable with again. They enjoyed different styles of activities. Before they started an activity they read the instruction carefully, such as how long they will take and how to do it. If they got the correct feedback, they were content and satisfied with their own study.

- Summary Reading

Most respondents read through the lesson summary after they finished a lesson study. If they felt confident with their learning after reading it, they would go to the lesson assessment straight away. Some respondents found they were not so good at some topics that they had been learning so they would go back to study them again.

- Lesson Self-Assessment Working

In the MK course design, the lesson self-assessments created more opportunities for enhancing respondents' learning. By means of feedback from the self-assessment questions, respondents had more opportunities to adjust their learning.

Apart from these six activities, the researcher found the knowledge and lesson maps were not used very often by the respondents. Though the researcher had mentioned both maps to the respondents, they were not keen to use them. The researcher interviewed the respondents after they finished the whole study about the reasons why they did not use them much. Most of them thought there were not many lessons for the study and there was not much meaning to check the knowledge map to navigate the lessons. As for the lesson maps, they thought they could use navigation buttons to navigate within the lesson as the structure of topics was very clear in the learning outcomes and navigation bar. They thought that if they were learning the whole MK course, they would use the knowledge map to navigate the course.

5.3.2 Summative test

At the end of the study, each student took a summative test. (See Appendix E) All the questions of the summative test were from the seven lessons of the observational study. All of them were multiple-choice questions. Figure 5.11 shows the scores of the six respondents.

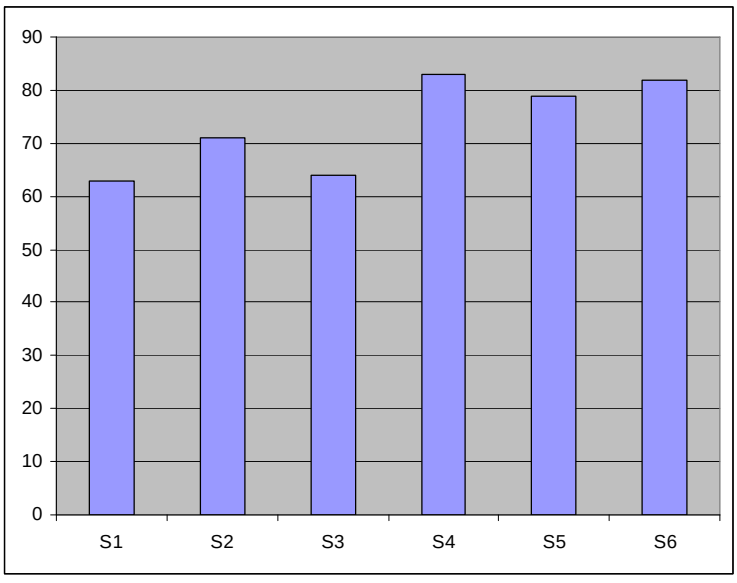


Figure 5.11: The scores on the summative test

From the above figure, we can see that all the respondents scored above 50%, which is the current pass mark for the MK courses. Thus, in general, their choices of learning activities lead to effective learning

6 CASE STUDY 2—AN EVALUATION OF ONLINE MASTERS PROGRAMMES

The second case study is of online distance learning courses leading to a Master's degree. This case study is another evaluation of students' perceptions of the CT based approach to course design. However, the kind and quality of learning design varies between the courses, as not all academic staff teaching the courses had sought and followed the advice provided by the DA-CMT Flexible Learning Support Centre (FLSC). The chief purpose of the case study is to validate the findings from the evaluations of the MK courses. The findings will also help the teachers to improve their approaches to course design

6.1 The background of the Online Masters Programmes

The online master programmes provide "eligible candidates with the opportunity to attain a post-graduate qualification through a combination of accredited military education, training and experience, and directed part-time academic study"[45]. As a set, they are referred to as the Modular Masters Programme (MMP) and form part of the OCD scheme described in section 4.1. It also means that people from the other British and foreign armed services, government departments and Private Venture students from a wide variety of backgrounds, will have access to a similar programme. The benefit to them also is that they can study without having to take a full year out of whatever else they are doing. The courses are structured as distance learning programmes (See figure 6.1), with each programme having up to twelve modules, some core, some elective.

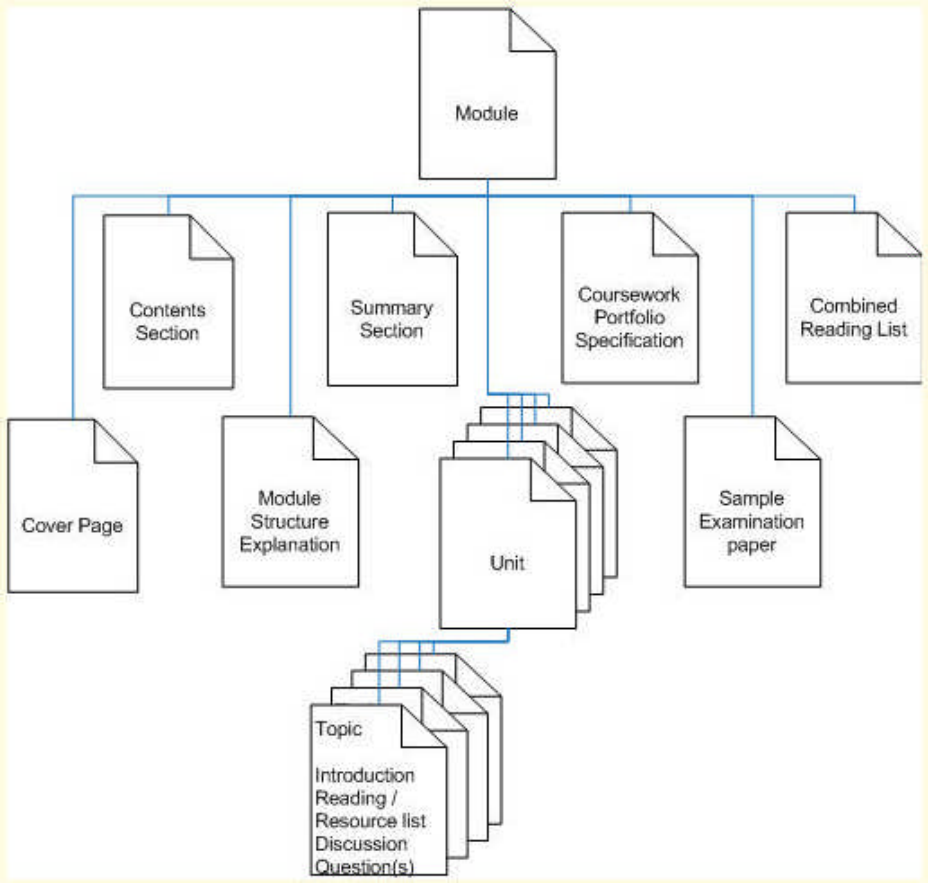


Figure 6.1: Course structure of an online Masters programme

The following figures, taken from a programme whose developers had sought and received advice from the FLSC, show examples of learning outcomes (listed as 'objectives') (figure 6.2), course content (figure 6.3), learning activities (figure 6.4), learning summary (figure 6.5) and learning self-assessments (figure 6.6).

Figure 6.2: Learning objectives

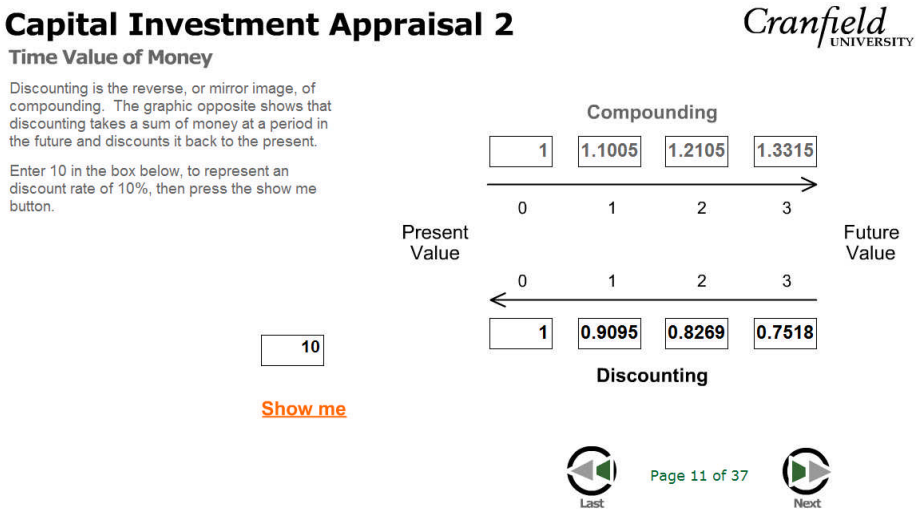


Figure 6.3: Course content

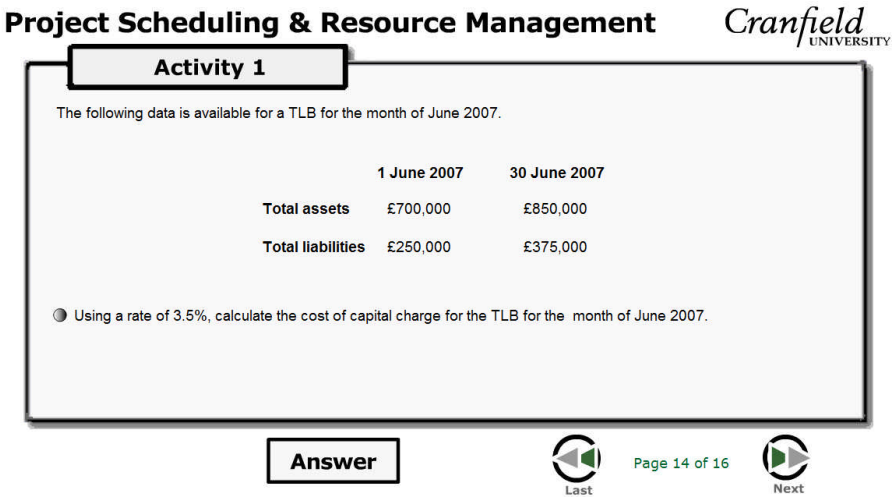


Figure 6.4: Learning activity

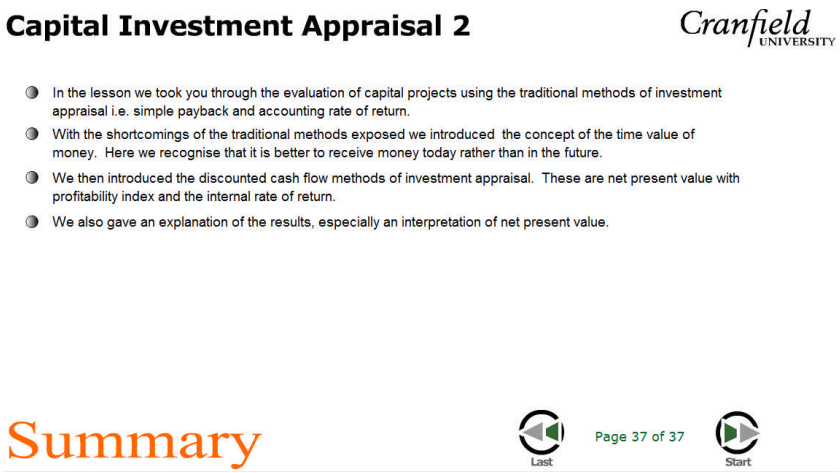


Figure 6.5: Lesson summary

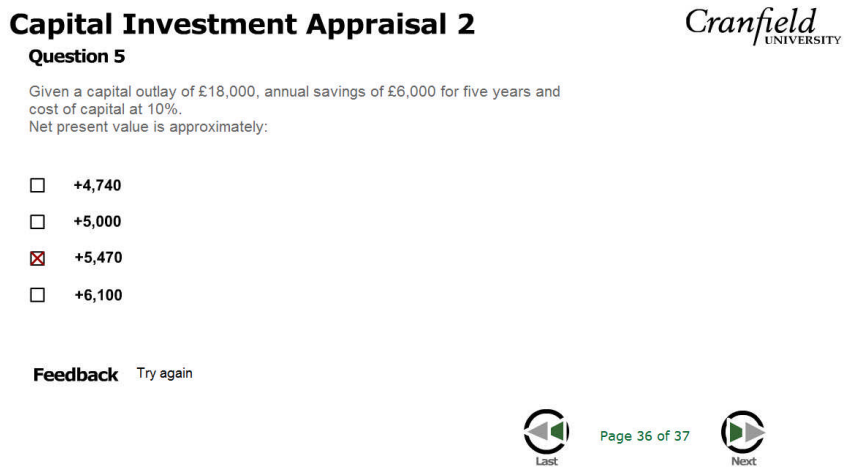


Figure 6.6: Lesson self-assessment

6.2 The evaluation of the Online Master Programmes

Another evaluation questionnaire was administered in the study. It is about the design features and overall effectiveness of the courses (See Appendix F). This questionnaire was conducted between November 2008 and February, 2009. The data collected from this questionnaire was used to address the research questions;

- **Are students satisfied with this kind of course design?**
- **What are students' perceptions of the features of the course design:**
  - Statements of learning outcomes
  - Knowledge map and Lesson maps
  - Learning designs using activities
  - Lesson self-assessments
  - Summaries

6.2.1 Questionnaire design

The questionnaire was developed based on the above research questions. Most questions were Likert scale .There were also several multiple choices and Yes/No questions. All of them provided information on respondents' views on the courses.

Questions included five sections: (1) respondents' perceptions of learning outcomes of course design; (2) their perceptions of site map; (3) their perceptions of the learning; (4) their perceptions of self-assessments; and (5) their perceptions of overall effectiveness of the course design.

The questionnaire survey was posted online via a link to the webpage. There was a short introduction explaining the aim of this study before students started the questionnaire.

➢ *Sample Selection*

The sample was drawn from the of students who had recently completed course modules

- *Response rate*

The survey lasted for three months starting from 1st November to 1st February 2009. There were 27 responses to the questionnaires. Of the 27 completed questionnaires, there was no missing data in the values found.

- *Validity*

The design of the questions was based on a literature review and input from members of the DA-CMT FLSC team. The same style of questionnaire has been tested and used previously for the MK courses.

6.2.2 Results and discussions

The results of the questionnaire were ranked and analysed according to five categories: items concerning the learning outcomes of the courses, site map and navigation, learning design, summative assessment and overall effectiveness. The mean of the response to each Likert scale question was calculated by multiplying the number of respondents for each rating by the rating number adding the results and then dividing that total by the total number of respondents.

- **Items Concerning the Learning Outcomes**

The results of specific questions (items 5, 9 and 10) in the evaluation questionnaire concerning the statements of learning outcomes are presented in Table 6.1 and Table 6.2. Particularly, there is the mean for each item in table 6.2. The mean was calculated according to the scores of each selection coded (very useful and always = 4, useful and frequently = 3, a little useful and sometimes = 2 and not useful at all and rarely = 1).

Table 6.1: Item 5 concerning the learning outcomes

Item Number	Item	Yes (%)	No (%)	**N/A (%)**
1	Did the module contain a clear indication of aims and learning outcomes?	100	0	0

Table 6.2: Items 9 and 10 concerning the learning outcomes

Item Number	Items	**Mean**
2	How useful the statements of learning outcomes?	2.20
3	How frequently did you read through the learning outcomes?	2.33

As can be seen from Table 6.1, 100% of students thought the modules contained clear indications of the learning outcomes. Table 6.2 indicates that items 2 and 3 were ranked the highest (2.20 and 2.33 out of a total 4.00). It seems that more than half students agreed that the learning outcomes were useful and that they read through them before they started the study.

➢ Items Concerning the Site Map

Items 4 and 5 in the evaluation questionnaire concern the design of the site map (see table 6.3). Both items have a mean of 2.43 and 2.48, suggesting that students mainly agreed that the site map helped their understanding of the structure of the course and for navigating through the course.

Table 6.3: Items concerning the site map

Item Number	Items	**Mean**
4	How useful was the site map for helping you understand the structure of the module?	2.43
5	How useful was the site map for helping you navigate through the module?	2.48

The item of Table 6.4 concerns the learning styles of the students. As can be seen from the table below, most students are serialist learners who worked through the units/lessons in a sequential order, which is similar result to the result from the MK questionnaire.

Table 6.4: Items concerning the learning styles of students

Item 6 Which descriptions best fit how you navigated through the module? (Tick one or more)	
Answers	Percentage of Total No
1. I worked through units/lessons in a sequential order.	85.7%
2. I worked on units/lessons in which I was interested.	4.8%
3. I first worked on the units/lessons where I was unsure of the content.	9.5%
4. I first worked on the units/lessons where I already knew something and then filled gaps in my knowledge.	9.5%

➢ Items Concerning the Learning Designs

Table 6.5 and 6.6 present the results of the questions in the evaluation questionnaire concerning the learning designs. As can be seen from Table 6.5, item 7 shows there are activities or self-assessment questions for most modules. The respondents were split equally 50/50 on whether they received any feedback or not. Just over half of the students thought that different media were used appropriately and effectively.

Items 10 and 11 in Table 6.6 concern the activities/ self-assessment questions. Respondents to these two items, were within a narrow range and scored close to 4 (mean = 2.75 and 2.63), represents that students were in agreement that the

activities/self-assessment questions facilitated their learning and that they frequently worked through them.

Table 6.5: Items concerning the learning designs

Item Number	Item	Yes (%)	No (%)	**N/A (%)**
7	Did the module use activities or self-assessment questions to support learning?	84.2	10.5	5.3
8	Did you receive feedback on how you could improve your learning?	50	50	0
9	Were different media used appropriately and effectively?	52.4	33.3	14.3

Table 6.6: Items concerning the learning designs (cont.)

Item Number	Items	**Mean**
10	If applicable, how frequently did you work through the activities/ self-assessment questions?	2.75
11	If applicable, how useful were the activities/self-assessment questions?	2.63

- **Items Concerning the Summative Assessment**

For the summative assessment of the course (see Table 6.7), item 12 is about the difficulty factor in following the procedures of the summative assessment. The mean was 2.50, which was calculated according to the sores of each selection coded (very difficult = 4, difficult = 3, easy = 2 and very easy = 1). It seems that the respondents did not find the procedures easy to use. This could be due to the fact that over half of the respondents found it difficult when operating an electronic assessment. It could also suggest that the environment was not user friendly enough and further direction and training for the assessment procedure might be necessary.

Table 6.7: Item concerning the summative assessment

Item Number	Items	**Mean**
12	How easy to follow were the summative assessment procedures?	2.50

- **Items Concerning Overall Effectiveness of The Online Master Programme**

Items 13 and 14 investigate the overall effectiveness of the courses as shown in table 6.8. The means were calculated according to the scores of each selection coded (strongly disagree = 4, disagree = 3, agree = 2 and strongly agree = 1). Item 13 is about the effectiveness of the environment on students' learning (mean = 2.43). This suggested

that students did perceive and agree with the course designers' intentions. Item 14, concerning whether they would be happy to do more online studying in the future, got a mean of 2.50. Over half of the students reported that they would like to use online studying again. Most of them agreed from item 13 that this online distance programme fitted in with their learning. It is an encouraging indicator that technology still has much potential for facilitating learning, if the materials are well-designed or suit learners' needs.

Table 6.8: Overall effectiveness

Item Number	Items	Mean
13	Working through the module has helped me become a more efficient and effective learner.	2.43
14	I would be happy to do more studying by online distance learning.	2.50

Overall, students' responses from this MMP questionnaire were analysed in terms of the four aspects of course design and also the overall effectiveness of the course design, similar to how the MK questionnaire was analysed. The results showed that students mainly held positive attitudes toward MMP courses and their course design features. Therefore from the first part of the research questions on course design it is well-supported that students in general perceived MMP courses positively.

PART 3 ADAPTIVE TEACHING

In the previous two parts, learning theories, course design and case studies have been discussed in order to better understand how to design a good course for students in an RBL environment. In most current RBL environments the task of improving learners' achievements is to rely heavily on the design of the courses as described above. Besides those aspects of course design already discussed and valuated, it is here argued that adaptively should be systematically considered as an essential element in a typical RBL environment.

Barra [10] defines "adaptivity as the ability to be aware of a user's behaviour and to take into account his or her level of knowledge in order to be able to provide the user with the right kind of instructional material". Hoschka [76] also describes "adaptation as being an important issue in the research of learning environments, since it can lead to better learning in such systems".

Apart from the many ways that have been used in Intelligent Tutoring Systems (ITS) and Adaptive Hypermedia Systems (AHS) to provide adaptation, a promising methodology that could be applied to RBL is Knowledge and Task Analysis described earlier in this thesis. The use of Knowledge and Task Analysis has been common practise for some time now. Pask and Scott developed CASTE (Course Assembly System and Tutorial Environment) based on this methodology in 1970s, this being an exemplifier of an integrated adaptive and conversational system [139]. In this study, the methodology of Knowledge and Task Analysis is employed in a RBL environment that helps guide the user. The methodology can be used to support online education, by assisting, tutoring and monitoring students throughout their learning process.

The purpose of this part of the study is to show that Knowledge and Task Analysis in RBL environments may be used to provide guidance for the learner, while increasing the adaptivity of the learning environment. The main goal, for which an approach and a methodology are suggested here, concerns two important aspects: (i) Students can choose their own learning strategy based on their learning styles and (ii) providing access to course materials adapted to levels of knowledge. This study considers multimedia, hypertext and adaptivity in building a RBL environment which takes into account the following 'factors':

- The teacher. As we described before, the educator is more than a mere dispenser of knowledge; he/she is henceforth a facilitator, a mediator between the knowledge and the learner.

- The construction of a sound pedagogy. This becomes a necessity through the convergence of the cognitive system of the educator and that of the learner in this new environment.

- The knowledge. The contents are not frozen, but in evolution. This means that the learning processes are not simple reproduction mechanisms; on the contrary, they should be meaningful learning environments.

- Learning styles. This study assumes that the learning styles of students should be considered in order to achieve adaptive teaching.

In this sense, the system aims to construct the adaptive teaching which is based on Knowledge and Task Analysis. In this proposed methodology, we will use a knowledge-based approach to identify students' problems and propose the algorithm, (Knowledge and Task Based Adaptive Teaching Sequences Construction, KTABTSC algorithm), to generate adaptive teaching sequences for helping students learn the required knowledge correctly and efficiently and to overcome the encountered problems.

This part of the thesis is divided into two main parts: the first describes, over three chapters, the current state of adaptivity. That is, it provides an exploration of the fundamentals of ITS and AHS. The second part contains one chapter concerned with the results of from an experimental evaluation of how adaptive teaching might be deployed in the MK courses.

7 INTELLIGENT TUTORING SYSTEMS

The concept known as Intelligent Tutoring Systems (ITS) has been studied by researchers in Education, Psychology, and Artificial Intelligence for more than four decades (see Figure 7.1).

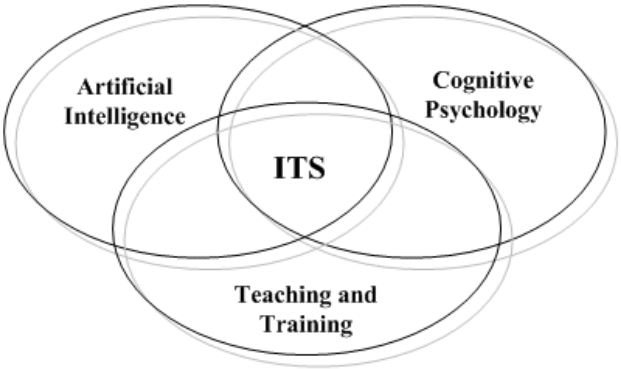


Figure 7.1: ITS domain

ITS apply Artificial Intelligence techniques to the development of educational systems based on computers with the purpose of building systems able to adapt dynamically to the learning as it occurs. In an ITS, not only the material can be presented in a flexible way but also student needs can be responded to flexibly. Pedagogical decisions are made by these systems, placing the system in the role of an 'intelligent' tutor.

Major [104] states that, " An ITS should adapt to a particular student by varying the difficulty of material, presentation style, help offered, path taken, and generality of the material." He further emphasises that "the path through the coursework is calculated whilst the student is using the system (i.e., it is not pre-environmental or pre-determined)". However, Kinshuk [90] argues that, "An ITS will typically constrain the student to learning by a predetermined method or strategy." He states that, "ITS use a model of the student's knowledge (student model) so that the student is presented with new information only when he/she requires it". Ridgeway [131] offers the criticism that, "Such systems have been constraining the student to solving a problem in a particular way." From this perspective it can be argued that an ITS also should offer choices to the student concerning how they learn. Pask and Scott's CASTE did this by allowing students choice over the learning strategy followed. This aspect of CASTE is partially replicated in the study reported below.

7.1 ITS components

Generally, there are four model components in each ITS, which are Knowledge of the domain (*domain model*), Knowledge of teaching strategies (*pedagogic model*), Knowledge of the learner (*learner model*) and Communication *model* (see Figure 7.2).

This basic outline of requirements was introduced by Derek, Sleeman and Hartley in 1973[70]. It has been used widely since then. Wenger [155] states that, "The goal of every ITS is to effectively communicate to the student its embedded knowledge by using the communication model."

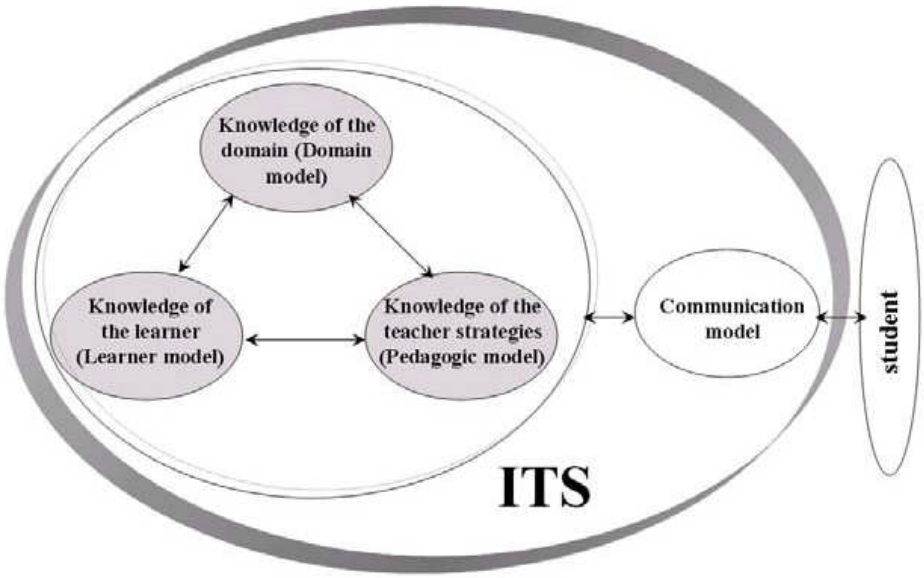


Figure 7.2: The necessary basis for effective teaching by an ITS

The ***domain model*** contains the knowledge of the subject matter to be learned and is usually pedagogically organized to facilitate the task of the pedagogic model. The knowledge represented in this module is used to determine what should be presented to the student and how to evaluate his/her actions and answers.

Through the ***pedagogic model*** the different teaching strategies are represented and the methods for controlling the session are implemented by means of the appropriate selection and sequencing of those strategies. This module design manages the teaching in order to promote the learning. It also has ability to decide how to use the information of the domain module and the student model.

The ***learner model*** represents the part of the system that has the knowledge of what the student has acquired during the instruction process. It may also incorporate other aspects of his/her behaviour and knowledge with possible repercussions on his/her performances and learning such as student demographics, prior learning achievements, favourite learning styles and motivation level.

The ***Communication model*** controls the interactions with the learner.

7.2 Advantages and disadvantages of ITS

ITS has proven highly effective, if it is properly designed. According to Shute [143], "ITS teaches twice as quickly as traditional classroom methods." Individualized instruction can be provided by ITS, which is difficult to achieve in a lecture-style class. Bloom [19] also mentions that, "Individualized instruction has proven extremely useful in improving the education of students."

A variety of knowledge skills have been taught via ITS. Eliot [53] developed LISP environment for learning how to treat heart attack patients. Realistic working environments have been developed in ITS for teaching people in technical fields [95] . The main feature of these systems is that they use simulations to provide complex and dangerous machinery for learners that would otherwise not be possible in a classroom. Though ITS are effective for teaching, it is not easy to apply them over the WWW. The main obstacle is of the lack of instantaneous interaction between the teacher and the learner in a web-based ITS. In addition, various authors have discussed a wide range of limitations of ITS (see Table 7.1).

Table 7.1: Limitations of ITS

LIMITATIONS	EXPLANATION
In teaching and pedagogical expertise	Pedagogical components are not enough in most ITS. In practice, some rules are used in those pedagogical components. It seems these rules can work reasonably. So there should be a good principled theory to follow to improve the rule-based teaching of students.
In authoring, architectures and delivery platforms	Bloom [18] identifies three main problems in ITS: 1) It is complex to author ITS. Most of the time domain experts are required to know all the knowledge of an ITS. 2) The users are not willing to accept the ITS, because there is not enough feedback from the teacher in the ITS. 3) Most ITS architectures cannot cross applications.

	They cannot be reused [90]. Bloom [18] points out that, “In order to be named ‘generic’, an ITS must have the ability to reuse the student model, the instructional model and the knowledge base inference mechanisms.”

7.3 Conclusion

As we can see from the above discussions of ITS, most ITS basically follow one pedagogical method in which the learner passively accepts the information given by the teacher or instructional media. De Corte [44] points out that, “One of the weaknesses of this method is that there are discrepancies between the concepts that the learners absorb and the contexts or situations where those concepts may be applied.”

On the other hand, RBL regards that the learner is the centre of the learning, which means they should have the capability of "self-directed learning”. In order to develop such a capability, a RBL needs to be designed to help them understand the learning materials. A knowledgeable teacher (automated or otherwise) would be essential to choose appropriate tasks, to provide rich and individualized feedback and to stimulate learning in authentic tasks. Students working with tools that act as intelligent cognitive amplifiers and in a supportive context that includes peers and mentors make these decisions themselves.

The concern centres on the students' possibilities to generate better feedback for learning than that of a tutor in rich but passive environments or if the students are in a better position to know what information they need for learning than the teacher is.

To clarify the above concerns, a research strategy is feasible. That is to use a sound pedagogical way into learning environments. For ITS, this means watching the functions of human tutors that can be usefully automated and assessing the quality of student learning they engender. The central question is about the possibility of developing learning environments that are able to suggest interesting tasks at the edge of students' skills or that are able to coach students and provide adequate feedback. If this were possible, the question turns into the use of Knowledge and Task Analysis of CT to specify subjects and topics of learning, and also into the quality of learning, that is, the skills and depth of understanding.

In short, the main point is that the idea from CT is to design adaptive teaching to support the view of student-centred learning. The combination of an Intelligent Tutoring Systems and an Interactive Learning Environment (CT based) as a basis from which to generate adaptive teaching environments is presented later.

8 ADAPTIVE HYPERMEDIA

In the last chapter, ITS was discussed in order to understand the current state of adaptivity. Adaptive teaching can act as cognitive tools for human learning [11], managing large amounts of information, serving as a pedagogical expert and creating meaningful environments for the learner. Adaptive Hypermedia Systems (AHS) are explored in this chapter.

8.1 Hypertext and hypermedia

The term “hypertext” was described as "non-sequential writing" by Ted Nelson in his publication *Literary Machines* [109]. Subsequently, hypertext has been understood by many researchers as an electronic technology in which a computer must be involved. For example, Fiderio [56] writes:

> *“Hypertext, at its most basic level, is a DataBase Management System (DBMS) that lets you connect screens of information using associative links. At its most sophisticated level, hypertext is a software environment for collaborative work, communication, and knowledge acquisition. Hypertext products mimic the brain's ability to store and retrieve information by referential links for quick and intuitive access.”*

A well designed hypertext system can effectively enable people to read, author and comprehend information. Traditional documents can typically allow people to read in a linear manner. Information has to be composed in a linear format by authors in the paper form of documents. However, hypertext gives the freedom from this linear format to readers and authors. Information can be structured by authors as information chunks in a web where there are interrelated links among them.

Hypermedia is often considered to have the same meaning as hypertext by some people. There are however differences between them. Hypertext refers to the relations among textual elements, while hypermedia includes relations among elements of any type of media.

Thus, Hypertext + Multimedia = Hypermedia

Hypermedia [32; 39] is not a new concept. It has been used in some approaches to document managing [14], education [1427; 55], and knowledge engineering [26]. In short, hypermedia is a kind of way to build systems for information. The information is represented and managed in a network which is comprised of multimedia nodes. These nodes are connected together by different types of links. The major advantage of these systems is to encourage users to actively interact with learning environments [97].

However, Hammond [67] argues that, “An active involvement of learners does not mean letting them browse in a hypertext database aimlessly. Students must be encouraged to

actively seek out information. This can only be achieved by giving well-defined tasks to students." In addition, some psychologists and educators have studied how to let students learn more efficiently and effectively in a learner-centred environment. They have studied the ways in which people learn. They have attempted to find the best ways of presenting knowledge. These ways can be used for developing materials for individual interactive learning.

Pereira [123] maintains that, "A hypermedia system for education should contain three significant components, a text database (and other media), a semantic network which interrelates the database components and enough tools to allow the user to explore the database and the semantic network." Jonassen [79] also suggested that, "A hypermedia system can be defined as a network of ideas." Learners can study the node content easily with the help of a network of ideas, because the structure of hypermedia is similar with the structures that exist in the human brain:

> *"The belief that hypertext can mimic human associative networks implies that an appropriate method for structuring hypertext is to mirror the semantic network of an experienced or knowledgeable performer or expert"* [82,81].

8.2 Adaptive hypermedia

As was discussed before, the important characteristic of a hypermedia application is that the navigation is much freer. Adaptive Hyper media (AH) not only can provide freedom in the navigation but also personalised content and navigational support can be automatically generated in AH. As De Bra [44] describes, "Adaptive hypermedia systems build a model of the goals, preferences and knowledge of the individual user and use this throughout the interaction to adapt the hypertext to the needs of that user." This section introduces the adaptivity approach as a feature to be considered when building successful adaptive hypermedia systems.

8.2.1 Types of adaptation

There has been a lot of research carried out in the study of how to build adaptation into learning systems in the last two decades. Some research also shows that a better learning environment can be provided in such systems with the application of adaptation.

There are two kinds of systems which have been developed to support users. They are the adaptable system and the adaptive system. According to Oppermann [113], "Systems that allow the user to change certain system parameters (that is, parameters that can be modified on explicit user request) and adapt their behaviour accordingly are called **adaptable**. Systems that adapt to the users automatically, based on the assumptions they make about user needs (psychological state, knowledge) are called **adaptive**." The whole spectrum of these two concepts is shown in the figure 8.1.

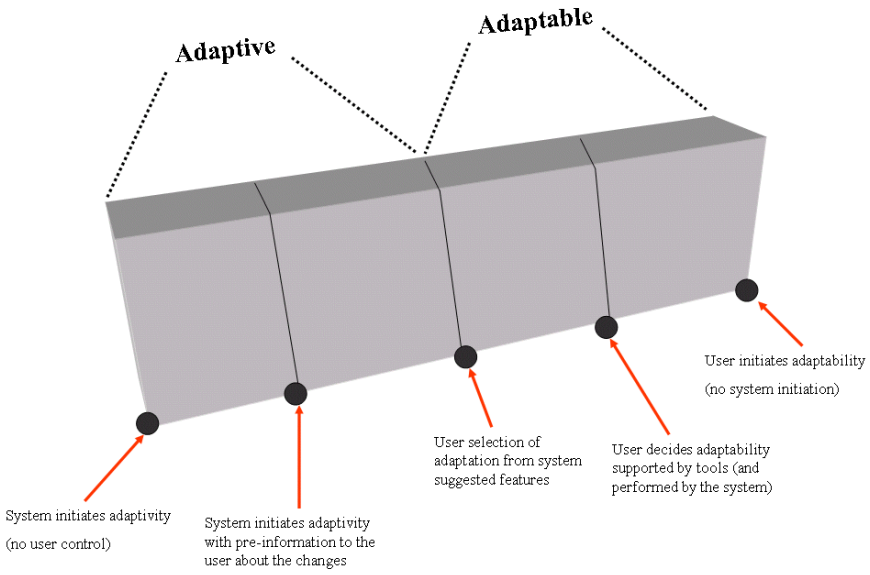


Figure 8.1: Spectrum of adaptation in computer systems
Source: base on Oppermann et al[114]

De Bra [43] describes the types of adaptation mentioned above, as follows:

> *"In an adaptable hypermedia system the user can provide a profile (through a dialog or questionnaire). The system provides a version of the hypermedia application that better represents the selected profile. Settings may include certain presentation preferences (colours, media type, learning style, etc.) and user background (qualifications, knowledge about concepts, etc.). On the Web there are several such sites that use a questionnaire to tailor some part of the presentation to the user. Adaptive hypermedia systems monitor the user behaviour and adapt the presentation accordingly. The evolution of the user preferences and knowledge may be deduced (partly) from page accesses. Sometimes the system may need questionnaires or tests to get more accurate information of the user's state of mind. Most of the adaptation, however, is based on the user's browsing actions, and possibly on the behaviour of other users as well."*

8.2.2 Adaptive systems

Adaptive systems are developed based on an adaptable hypermedia system and an adaptive hypermedia system. Benyon [16] states that "Adaptive systems are systems which can alter aspects of their structure, functionality or interface, in order to accommodate the differing needs of individuals or group of users and the changing needs of users over time."

Adaptive learning systems emphasize the following aspects:

- The learning experiences of learners are adapted readily by adaptive learning systems according to the learner's skills and needs.

- The content of the systems can be widely reusable.
- Systems can cross different platforms.

Benyon [15] proposed a global architecture for adaptive systems. He states that, "Adaptive systems must have three essential parts: a *user model*, a *domain model* and an *interaction model.*" (See Figure 8.2.) This particular architecture has been adapted for information systems, electronic mail filtering systems, multimodal systems and other similar systems.

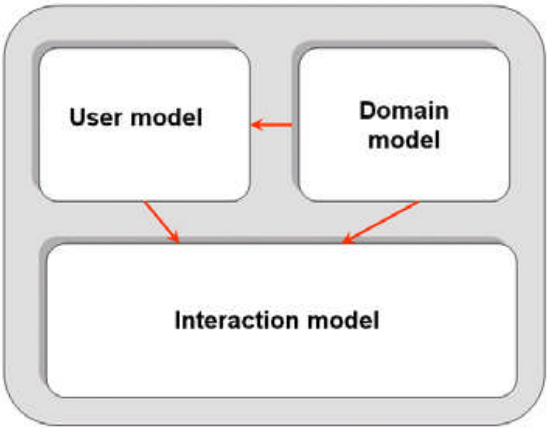


Figure 8.2: Global architecture of an adaptive system

- The user model

Benyon and Murray notes that, "The user model is required in an adaptive system because it can alter aspects of the system in response to certain given, or inferred, user characteristics[42]." User models contain the types of knowledge that the system has about the user. As was described previously, there is similar data about the user model in Intelligent Tutoring Systems. This is called the student model. The user model component is created directly from the domain model, and data may be kept at the following levels:

• The intentional level that describes the user aims in the domain;

• The logical level that describes the user knowledge of the domain; and

• The physical level that records the user (inferred) knowledge.

The user knowledge and the user erroneous beliefs are recorded at each of the above levels in the user model. According to Kobsa [92], there are two sorts of user modelling which is knowledge-based and behavioural user modelling. He notes that, "Knowledge-based user modelling is typically the result of questionnaires and studies of users, hand-crafted into a set of heuristics; behavioural models are generally the result of monitoring the user during his/her activity." Stereotypes as stated by Rich [130] "can be applied to both cases, classifying the users into groups (or stereotypes), with the aim of applying

generalisations to people in those groups". Behavioural user models can also be classified in overlay and perturbation models. Overlay models are widely used in adaptive hypermedia systems for education. The system builds a model of the user knowledge on his/her progresses which is a concept-by-concept basis. Brusilovsky [31] also mentions that "concept-by-concept allows for a flexible model of the student knowledge for each topic". The domain knowledge must be represented by specific topics. Uses of this model can be observed in systems like CASTE[119], HANDLEBAR [37], SCHOLAR[141] , INTZA [66], MetaDoc[23], HYPERTUTOR [124] and WebPVT [152].

One of the simplest ways of creating user modelling is to build fixed stereotypes. Adaptive hypermedia systems often combine the stereotype and overlay techniques to carry out student modelling in education. The stereotype technique may categorize the student model initially. Then the overlay model is gradually built from the initial student model according to the information on how the student interacts with the system. Other user models are also used for modelling the learner's knowledge and faculties. This is the case of the fuzzy models that use fuzzy logics to allow a more realistic evaluation of the student performance [88].

- The domain model

The domain model is responsible for defining the aspects of the application which can be adapted in the adaptive system. There are a number of purposes that are served by the domain model. The inferences and predictions that are made from the interaction of the user-system are created on the basis of the domain model. A description about the domain is formed in the domain model. The description contains facts about the domain, for example, the concepts and the relationships between concepts. Thus, what level of description should be represented is a central question in the design of a domain model.

The knowledge representation and articulation in educational systems implementation will determine the content of the tutorial interaction and the structure that will govern an adaptive instruction [35] . To design the instruction process in adaptive systems it is necessary to know, for example, the order in which the concepts will be presented and the existing relationships between them. The ways in which those relationships help in the process, in the learning difficulties, in their prerequisites and in representing points of view or in explaining concepts are also important. Therefore, a great quantity of didactic information exists which is associated to each concept or group of concepts. The designer should be aware of these when teaching and they should be collated in the domain description.

Fink [57] states that in the area of Artificial Intelligence, domain knowledge refers to the subject matter material, and that there are various ways of representing it depending on the nature of the knowledge itself. As described above, topic maps are used in this research to represent the domain knowledge.

- The interaction model

This component represents the actual and designed interaction between the user and the application. An interaction is the action of the user to work with the system at a level

which can be monitored. Inferences about the user are made from the data which is gathered from monitoring. The inferences are about the user beliefs or some long-term characteristics, such as cognitive traits or profile data.

Benyon [15] states "The system may tailor its behaviour to the needs of a particular interaction or, given suitably 'reflective' mechanisms, the system may evaluate its inferences and adaptations and adjust aspects of its own organisation or behaviour (i.e., it must decide the appropriate moment to provide some indications based on user interaction)." The next figure shows in detail the interaction model architecture as proposed by Benyon [15].

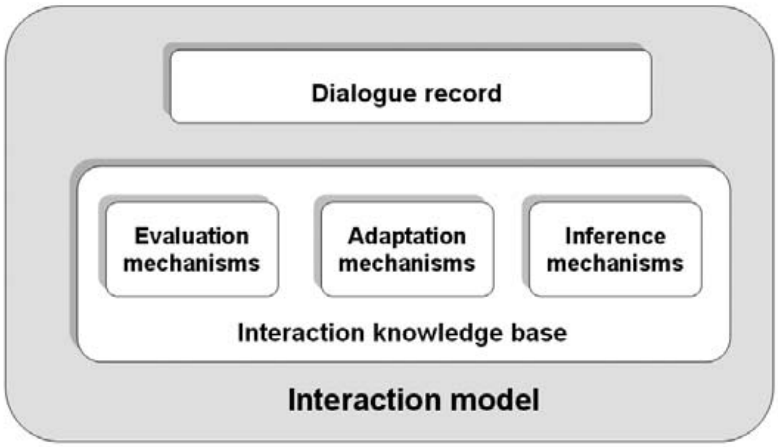


Figure 8.3: The interaction model architecture in adaptive systems

8.3 Web-based adaptive educational systems

Web-based educational systems can solve the problems caused by the physical distance-between teacher and students. In this context, the internet is a huge resource for learning. As was discussed before, the role of teachers is to be the significant assistant rather than the information provider. Thus, more efficient mechanisms of adaptivity are required in RBL environments. In web-based adaptive educational systems, the teacher's role must be performed as much as possible. The system can help students to navigate via the course activities. Students can get support in task accomplishment and exercises.

According to Brusilovsky's studies [28], "Currently, adaptation technologies applied in Web-based adaptive educational systems are adopted from either the ITS area. For example: Curriculum sequencing, Intelligent analysis of student solutions, Interactive problem solving support, Example-based problem solving support and Collaboration support; or the adaptive hypermedia area such as: Adaptive presentation and Adaptive navigation support."

- Adaptive presentation

Brusilovsky [27] uses this term to indicate "the adaptation of what is shown on a single screen or page". The function of adaptive presentation in a system can adaptively

generate or assemble pages from pieces for each other. For example, more detailed and comprehensive information can be provide to expert users, while additional explanations are provide to novices.

In the web-based learning environments, the same page has to suit different students. From this perspective, adaptive presentation is very important. C-Book [87] and De Bra's adaptive course on Hypertext [34] are two web-based adaptive educational systems that implement full adaptive presentation.

In some other systems, adaptive presentation is used in different contexts. Eliot [52] developed Medtec in which adaptive summaries of book chapters can be generated. ELM-ART [27], AST[146] and InterBook [30] provide adaptive warnings about the educational status of a page through adaptive presentation. For example, a textual warning is able to be inserted at the end of a page which is not ready to be learned in ELM-ART and AST. A red bar is a warning image which can be inserted in the InterBook. The page variant technique is used in Anatom-Tutor [12] and C_Book [87].

- Adaptive navigation support

The technology of Adaptive navigation support is to provide orientation and navigation for the student in hyperspace. This is done by changing the appearance of visible links. Adaptive Navigation Support (ANS) helps students to find an "optimal path" through the learning material. ISIS-Tutor [29] and Hypadapter [73] are two examples of ANS-based systems from the domain of teaching materials. Adaptive hiding and adaptive annotation are used in ISIS-Tutor. Hypadapter uses adaptive hiding and adaptive sorting. Annotation is the most popular form of ANS on the WWW. It is implemented in ELM-ART, InterBook [30] and AST.

8.4 Conclusion

In this chapter, hypertext and hypermedia technologies have been reviewed according to the research interest of this thesis applied to educational systems throughout the web. Most of the web-based systems that are being used in educational environments have been shown in the presented literature. Overall course control can be supported by adaptive sequencing. Adaptive sequencing can also help the student select the most relevant tests and tasks.

The consensus and differences between ITS and adaptive educational hypermedia (AEH) are briefly compared here. For ITS, intelligent behaviours of the system, e.g., tutoring discourse in natural language, diagnosis behaviour are emphasized. Mapping to educational theory, typically ITS is closer to a tutor-centred paradigm in general. ITS controls and decides what is best to the learner firmly based on the system’s student model. Under the development of novel media technology such as Web hypermedia, typical the ITS approach may lack flexibility and usability since learners lose the chance to explore the information space, e.g., browsing content freely as people used to do on the Web. Whereas for AEH the main concern is offering learners adaptive presentation and navigation support according to each learner’s prior knowledge and preference.

AEH is much closer to the learner-centred educational model, i.e., a model of constructivism. It also attempts to adapt the content to the individual learner but the adaptive design targets sharing learners' cognitive load and/or reducing the hypermedia disorientation, not performing full intelligence to make all decisions.

In this research, we propose to balance these two extremes via the methodology of Knowledge and Task Analysis which separates concepts and tasks. So at the concept level, the focus-of-control resides at the user-side. Learners could freely study learning concepts. Nevertheless these concepts are filtered and recommended by the tutor. At the task level, the focus-of-control resides at the tutor-side. The environment (i.e., the tutor) determines what task is to be carried out.

9 KNOWLEDGE AND TASK BASED ADAPTIVE RBL ENVIRONMENT

This chapter shows the logical and technological solutions proposed for the development of a Knowledge and Task Analysis based adaptive environment (KTABAE).

By considering adaptive RBL, the first issue is naturally to ask, "What information is different between individual learners?" That is, it is essential to identify types of information associated with learners, so that the task of adaptivity can then be done accordingly. Moreover, such information should be a meaningful discrimination in terms of learning. The most significant information that has been used in most adaptive systems is learners' knowledge. By considering what the user has known or not known, the system generates appropriate adaptation effects in terms of his/her knowledge status of the learning domain. Besides learners' knowledge or performance on the topics to be learned (i.e., the learning domain), other differences between learners is considered potentially beneficial for adaptivity, it is the different ways in which people learn. This is so-called learning styles.

9.1 Learning styles

The theory of learning styles states that different learning results are brought about by the way learners perceive and process new information. In order to use learning styles as a way of identifying differences between individuals, it is essential to first clearly define what learning styles are and then design teaching activities to cater for learners with different traits, this is a kind of adaptivity.

Here is a clear explanation of learning styles [48], "Learning styles are strategies, or regular mental behaviours, habitually applied to learning, particularly deliberate educational learning, and are built on his/her underlying potentials." Many endeavours are being made to identify features of learning styles that can classify learners into distinguishable features. An overview of the development of several models of learning styles is presented below.

One of the theorists was Jung, whose Psychology of Types [84] identified four types of individuals based on inherent personality traits. He names these four function types *feelers, thinkers, sensors and intuitors*.

Other psychologists such as Witkin [159], Kagan and Kogan [85] identified other cognitive factors which differentiate individuals' responses to learning environments. Witkin distinguished between learners who rely on context to establish meaning (*field dependent*) and learners who rely more on their own analytical skills than on the context (*field independent*). Kagan and Kogan's [85] contribution was the distinction between *impulsive learners*, who respond quickly and intuitively to questions and *reflective learners*, who make a deliberate and thorough examination of all alternative answers before responding.

Drawing upon Jung's[84], Witkin's[16085], and Kagan and Kogan's concepts[85; 159; 160], Kolb [93] set up his concepts of learning styles. He discovered that learners can be differentiated apart in the way in which they integrate new information into their existing cognitive structures. His theory differentiates learners along two continua: whether they prefer to process information through active experimentation or reflective observation, and whether they prefer to perceive new information from a concrete experience as opposed to abstract conceptualization.

Kolb's [93] distinction along the processing continuum between active experimentation and reflective observation is similar to Kagan and Kogan's distinction between impulsive and reflective learners. While the distinction along the perceiving continuum between abstract conceptualization and concrete experience is similar to Witkin's distinction between field independent and field dependent learners. The combination of the two dimensions of processing preference and perceiving preference results in four different learning styles, these are named *divergers, convergers, assimilators, and accommodators.*

In other words, learning style encompasses both the perceiving and the processing of information and the interaction between the two. Each type has its own characteristics and learning preferences. Kolb[94] referred to learners who process information reflectively and perceive it concretely as divergers. Learners who process primarily through reflective observation and perceive through abstract conceptualization are called assimilators. Convergers are learners who prefer to perceive using abstract conceptualisation and prefer to process using active experimentation. Accommodators are learners who process through active experimentation and perceive primarily through concrete experience.

In this research, the researcher prefers Pask and Scott's [120] pair of distinctions of learning styles. They[120] set up their concepts in their model of experiential learning. They discovered that learners are differentiated in the way in which they integrate new information into different level learning. They described learning styles called *serialist* versus *holist* and aspects of learning called *operation learning* (learning about 'how' knowledge) and *comprehension learning* (learning about 'why' knowledge), where operation learning often benefits from a serialist approach and comprehension learning often benefits from a holist approach. Kolb's four learning styles are similar with Pask and Scott's, but the latters'[116] emphasis is on adapting the model for use in course design. Pask and Scott focus on the course structure which would benefit each type of learner. There approach is to do Knowledge and Task Analysis in the course design so that each type of learner will benefit.

The following describes Pask and Scott's two types of learners and their characteristic learning preferences.

They describes "*Serialists as those who* prefer to learn in a sequential fashion, that is one topic at once, whereas *holists* prefer to learn in a hierarchal manner (i.e., top-down), in parallel, on many topics at once; a *holist strategy* is then a 'many-at-once' approach and a *serialist strategy* is a 'one-step- at-once' approach; a learner who can adopt either approach to fit task demands is said to be *versatile"*.

They argue that course design should have regard for the two types of learners. They urge educators to present the course design in a process which goes from the creation of personal meaning to the specific theories and content. The designer should also consider ways in which theory can be applied, and then to be creative in ways of altering or experimenting with ideas. If the course design is presented in this way, each type of learner will have an opportunity to view the material in his or her preferred style, and also be exposed to a more holistic view of learning as the material is presented in other styles to that they are used to. Pask and Scott[120] believe that instructional strategies should not just be aligned with the student's preferred mode of learning, but should be intentionally varied to make learners become more flexible and gradually move away from the dominant mode to take advantage of other learning modalities.

An understanding of the ways students learn is the key to educational improvement. In order to improve the performance of all types of learners, Pask and Scott[119] developed the CASTE (Course Assembly System and Tutorial Environment) to assist teachers in their instruction based on the differences in the way people learn.

9.2 The early application of Knowledge and Task Analysis in CASTE

CASTE was developed by Pask and Scott in 1970s[119]. It is an exemplifier of an integrated adaptive and conversational system. It was designed in accordance with clearly pedagogical and course design principles of which was described in the above sections. Here are a few features of CASTE:

- It can regulate the uncertainty of students' learning. (Helping students decide what to learn and how to learn)
- It ensures students' learning leads to a good quality of understanding.
- Knowledge elicitation for assessment purposes and course design.

CASTE is a "free learning" situation. There is no imposed teaching strategy. Students can carry out their learning by a preferred style or approach. According to Pask[116], there are two main strategies of students to use learning materials. One is a holist strategy and the other is a serialist strategy. The students who use a holist strategy prefer to access many "topics" (chunks of learning material), so they can build up an overview of the subject matter. After that, they may attend to a specific topic. On the other side, students who use a serialist strategy like working in a one-step-at-once manner. They will not access further topics until they learn the details of a particular topic. Subject matter topics are presented on CASTE in a way that supports holist or serialist strategy. Figure 9.1 shows the main features of CASTE.

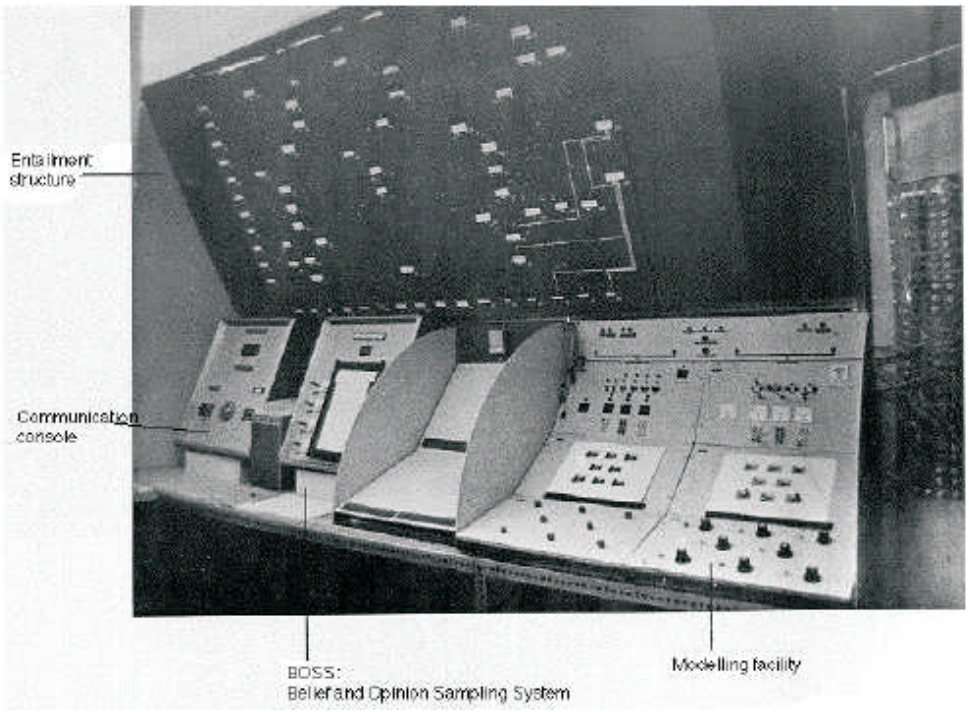


Figure 9.1: CASTE
Source: Based on Scott[138]

- There is a concept map for the course as a whole. It is an entailment structure that is in hierarchical form. It can show possible learning routes.

- A modelling facility can demonstrate topics to students and assess the understanding of students' learning according to well-specified task structures.

- BOSS (Belief and Opinion Sampling System) can sample the uncertainties of students about topic choices and topic content.

- A communications console can show different transaction types. For example, state aim, select topic, elicits demonstration and submits explanations.

There is also a suite of tutorial heuristics that is used to monitor transactions and model students' behaviours. The tutorial heuristics are written as computer environments. Permitted learning routes can be specified by the tutorial heuristics. This is the main role of the tutorial heuristics. Both a student's current understanding of topics and his or her preferred learning strategy are taken into account in the tutorial heuristics in order to produce the learning routes.

Scott [138] describes the basic rules of the system as, " The learner could only work on a topic, if she had demonstrated that she understood a set of prerequisite, subordinate topics from which the topic in question could be derived (there may be several such sets if there are analogies depicted in the entailment structure); having received one or more demonstrations of a topic the learner was constrained, at some stage, to produce a

different demonstration to show that she understood the topic (all the transactions at the modelling facility were mechanically detectable and scorable)."

From the basic rules of the system, we can see that it ensures the understanding of "why". The student accesses topics in a logically coherent sequence then he or she needs to provide the expository narrative which reveals the relations between topics of the entailment structure. BOSS uses multiple choice style questions that require students to give the explanations of "why". Meanwhile, the system ensures the understanding of "how". Knowledge and Task Analysis explains a particular topic by modelling activities. The student demonstrates understanding of "how" for all subordinate topics.

9.3 The need for Knowledge and Task Analysis

As was described before, Knowledge and Task Analysis is a kind of way of knowledge representation. In this study, in order to use domain experts' knowledge to identify the student's encountered problems and to generate adaptive tutoring information, a domain Knowledge and Task Analysis is utilized. This represents the domain experts' knowledge in our methodology in which there are two main advantages for using Knowledge and Task Analysis as described below.

(1) In general, a topic map consists of knowledge and task analysis. The idea of this study is that it is easy to use knowledge analysis to represent the learning concepts and domain concepts of the teachers' domain knowledge. Meanwhile, task analysis is built to help identify the students' problems and generate the adaptive teaching sequences through our proposed methodology.

(2) The researcher wants to identify not only the problems but also the related learning concepts about them for conducting adaptive tutoring. In addition, the researcher also consulted with domain experts to work out the related domain courses and quizzes. They are bundled with the corresponding concepts on domain knowledge and task analysis. Hence, in this way, it is convenient to generate adaptive teaching sequences for our methodology as shown in Figure 9.2. In the proposed methodology, the relations of Knowledge and Task Analysis are used to generate the adaptive teaching sequences.

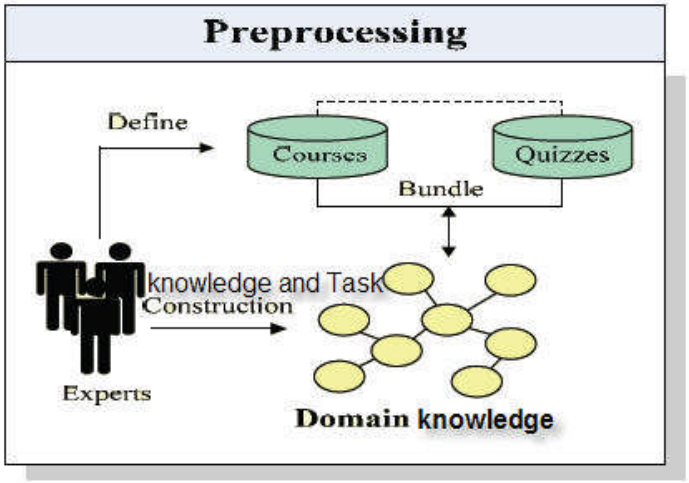


Figure 9.2: Domain Knowledge and Task Analysis bundled with courses & quizzes

9.4 KTABAE conceptual model

The conceptual model of the KTABAE system is based on the combined ITS and adaptive hypermedia approaches. There are three basic modules in this system. They are domain module, learning module and diagnosis module. The domain module is the knowledge domain which decides what concepts are to be taught and their interrelationship. The learning module considers of different features of the learner. For example, the knowledge of students and learning style of students are considered in the system. The diagnosis module provides adaptive sequences and feedback by means of supervising the student interaction with the system. Figure 9.3 shows the overview of the system.

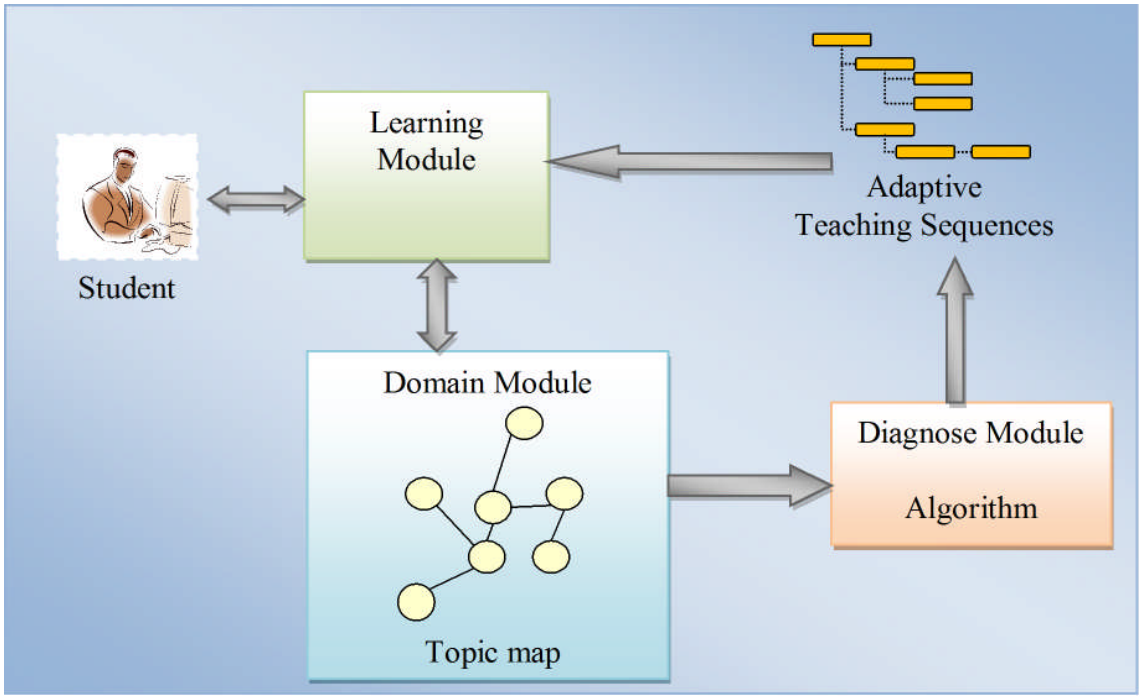


Figure 9.3: Overview of the adaptive Teaching System

The Learning Module of the system is a learning platform which is designed to provide students learning sequences with theoretic courses for learning the required domain knowledge.

Next, the Domain Module is used to help students identify their encountered problems. It is utilised to represent the topic map of the domain knowledge for identifying the students' problems and the related learning concepts.

Finally, the Didactical Module is used to generate the adaptive teaching for students by our proposed algorithm. If the diagnosis results show that the tasks have problems. The algorithm will take the domain topic map as input sources and generate adaptive teaching sequences.

9.4.1 Learning module

The Learning Module is a learning platform which is used to help students learn or improve the required domain knowledge for completing their tasks. As shown in Figure 9.4, the learning module contains a content package repository used to store and retrieve the learning sequences. When students would like to learn some domain knowledge, the learning sequences will be provided for them from the content package repository.

The learning sequences generated by the Knowledge and task analysis-based Learning Sequences Construction Scheme are used as basic tutoring courses to help students to learn the required domain knowledge as shown in Figure 9.4.

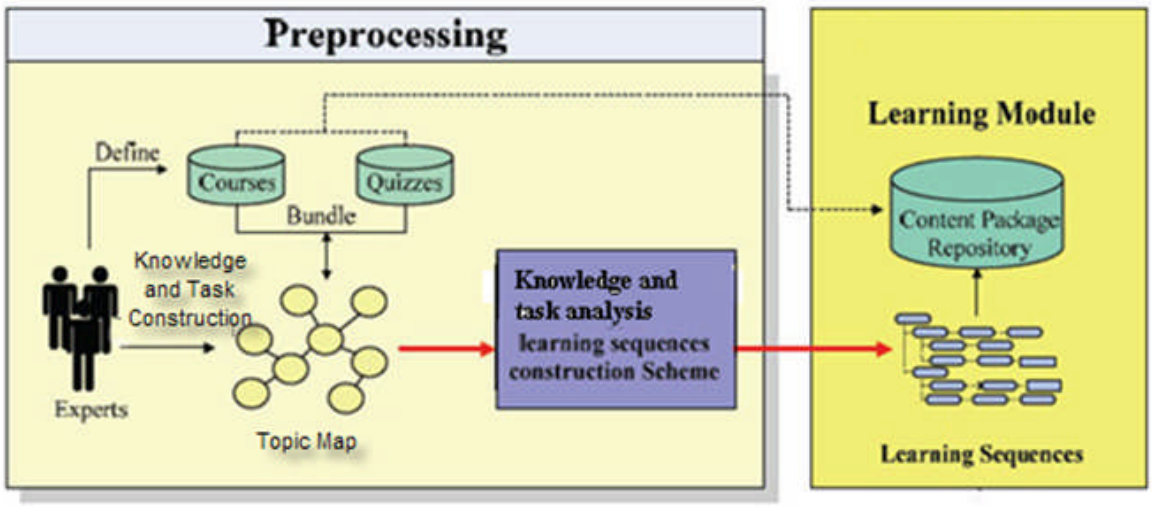


Figure 9.4: Knowledge and task analysis-based Learning Sequences Construction Scheme transformation

9.4.2 Domain module

One important part of an adaptive hypermedia system is the domain model which represents the knowledge of a particular domain. This knowledge will be transmitted to the student. The domain model also presents the way of presenting that knowledge that conforms to the rules. These rules are defined in a pedagogic model. The knowledge of the domain model determines the contents of the tutorial interaction. The structure of the knowledge can govern the adaptive instruction.

In this study, the domain model of KTABAE was represented by means of a topic map (see Figure 9.5) whose structure takes into account the *conceptual knowledge (*the ***why***) and *procedural knowledge (*the ***how***) focus. As we described before, topic map is used in knowledge and task analysis. There are two parts in the topic map. One is the entailment structure of concepts which are about the knowledge of why. The other part is task structure which shows the knowledge of how of a particular topic. The figure 9.5 shows the full topic map of ISTAR. The figure 9.6 shows the lesson map of ISTAR.

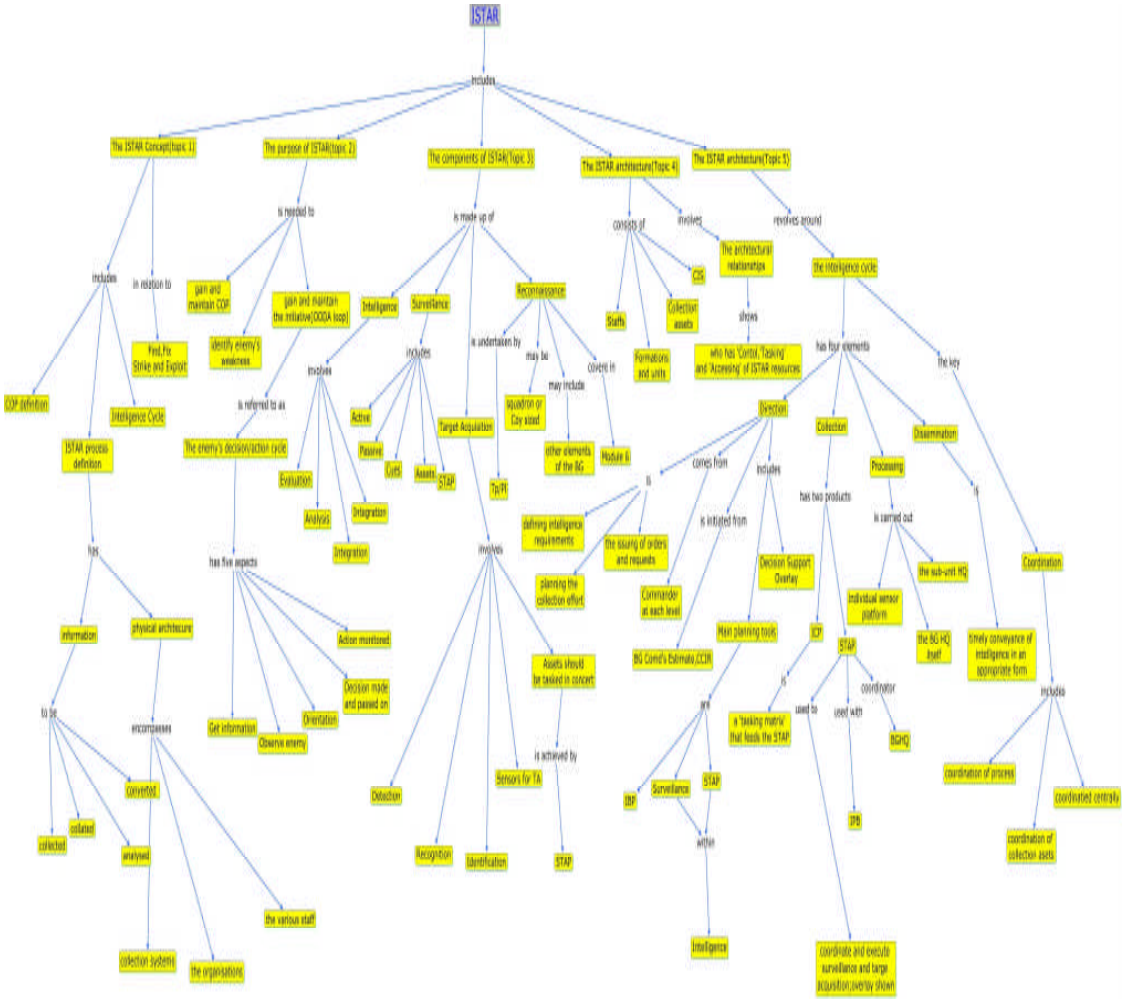


Figure 9.5: The full topic map of ISTAR

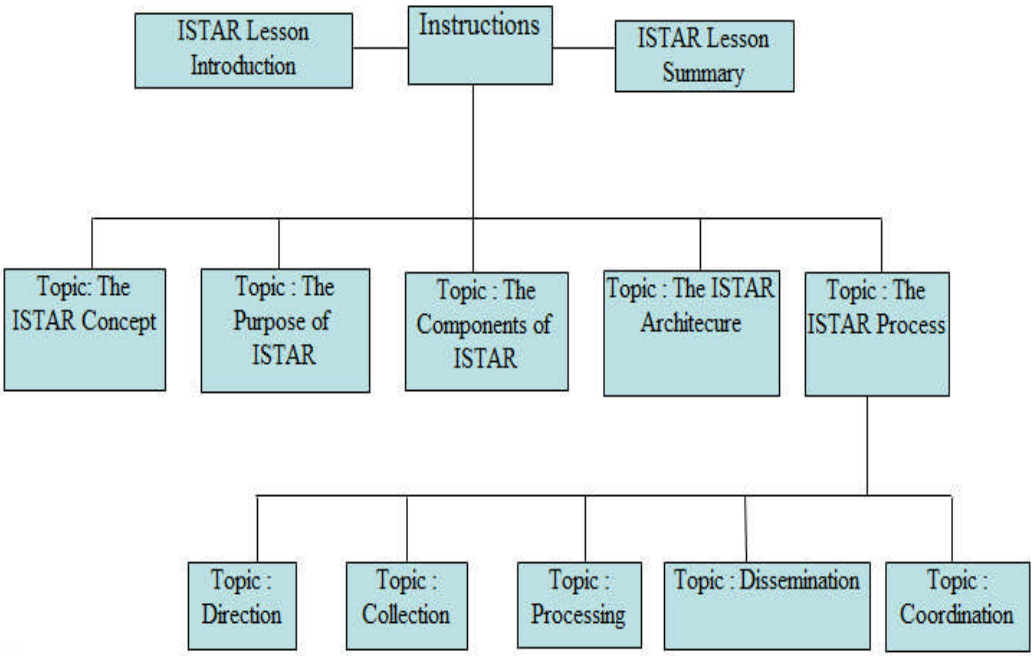


Figure 9.6: The lesson map of ISTAR

9.4.3 Diagnosis module

The Diagnosis Module is designed to identify the students' encountered problems in Learning. The Diagnosis Module is used to play the role of master teacher in KTABAE. In other words, it is a kind of virtual teacher in our system. When students complete their tasks, this Diagnosis Module could be used to diagnose the tasks. It would collect the required facts by one major method: a question-and-answer approach.

By using this approach, the Domain Module will ask users some questions about their tasks for getting facts. Next, they must answer the questions and the same question-and-answer processes will be repeated several iteration to collect all the required information. If, after being diagnosed, there are any major configuration or administration problems identified, students would then require an adaptive remedial tutoring process to improve their domain knowledge (and skills) in order to solve those problems. Therefore, the functionality of the Diagnosis Module is designed to generate adaptive teaching sequences for students' requirements.

As described above, the researcher proposed the rules, called **Knowledge and Task Analysis-Based Adaptive teaching Sequences Construction Rules** to generate adaptive teaching sequences. As shown in Figure 9.7, the inputs to the rules are a domain topic map.

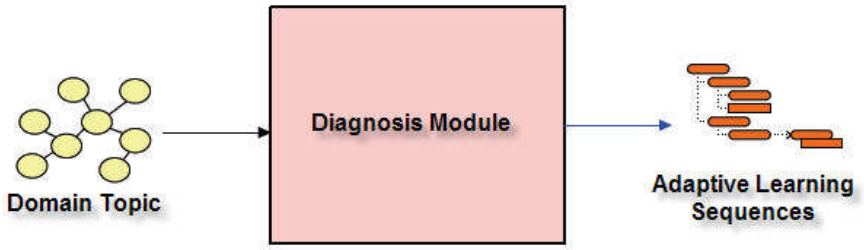


Figure 9.7:Diagnosis Module

The algorithm takes advantage of the topic map to identify the students' problems and the related learning concepts. This domain topic map contains not only the common error problems but also the related concepts. In brief, the diagnosis Module will utilise these related concepts to generate adaptive teaching sequences by the algorithm. In the next section the algorithm will be described in more detail.

As shown in Figure 9.7, the inputs of the algorithm are the domain topic map. The outputs of the algorithm are adaptive teaching sequences. The topic map is defined by domain experts for representing the common tasks and related learning concepts.

The main idea of the algorithm is that the researcher integrates the diagnostic information of tasks with the specific topic map consisting of error problem nodes and the related learning concept nodes. The specific leaning concepts nodes and error problem nodes can reveal the related leaning concepts about the students' encountered problems easily if we map the paths on the topic correctly. Thus, the KTABAE system will take the related learning concepts found on the topic map and generate the adaptive teaching sequences to help students solve their encountered problems. The following are the basic rules of the system.

1) Experts or teachers should set the default KTABAE.

2) Students log into the system asynchronously and "explore" the subject domain by accessing brief descriptions of topic content and examining the relationships between topics.

3) Students select a topic as one that they wish to come to understand. The student can only work on a single topic.

4) Students answer questions.

5) When a student has finished answering their questions, the system assesses them with the topic map. If the result of this assessment is correct, the topic in question is marked understood by the system.

6) If the assessment result is failure, the learner is directed to request further demonstrations.

7) Students repeat step 2.

8) At some stage, by some route, the learner is led to demonstrate his understanding of the head topic(s) and the tutorial is over.

Figure 9.8 displays the flowchart of the KTABAE rules.

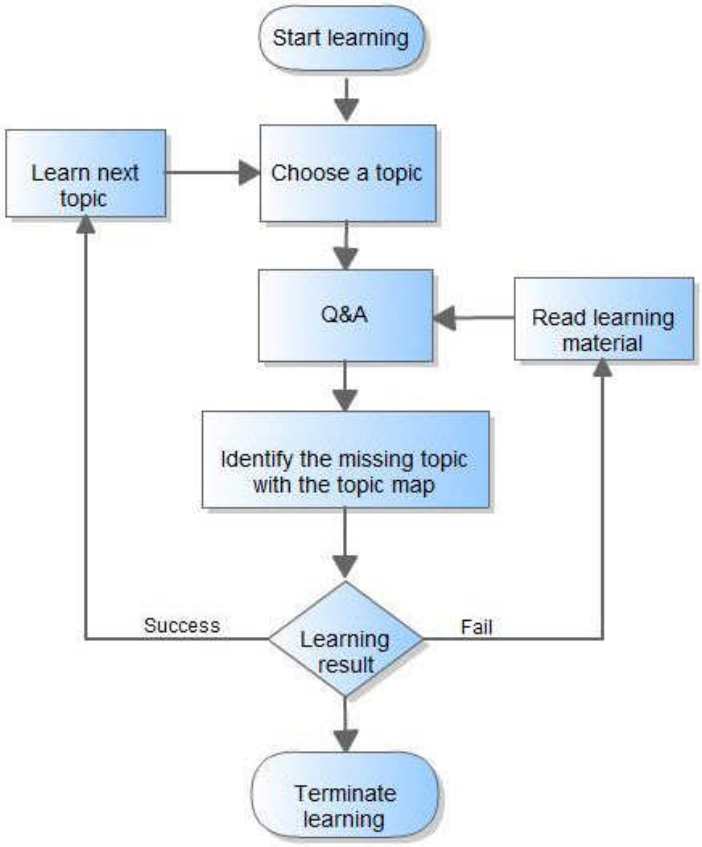


Figure 9.8: Flowchart of KTABAE rules

9.5 Design and Implementation Issues

With the proposed methodology, a prototype of the KTABAE system was built by the researcher. After comparison with many e-learning tools (see appendix G), an open source software tool, Courselab, was used for the research. Courselab is an e-learning authoring system that can create high-quality interactive e-learning content which can then be published on the Internet, Learning Management Systems (LMS), CD-ROMS and other devices. Learning modules created using CourseLab are compliant with the following e-Learning standards, AICC (The Aviation Industry CBT (Computer-Based Training) committee), SCORM 1.2 (Sharable Content Object Reference Model) and SCORM 2004 (SCORM 1.3).

Adaptive teaching for MK could be used at the level of whole lessons to direct progress from one lesson to another. Ways of doing this were investigated, but all were too technologically complicated to implement. It was decided to focus on the use of adaptive teaching to direct progress within a lesson from topic to topic, as this could be implemented using Courselab. Another advantage of studying adaptive teaching within a lesson was that the learning task was much smaller.

Finally, a KTABAE lesson package was developed using this tool. Within this package, the proposed KTABAE system was designed and built to provide adaptivity and student assistance. The KTABAE teaching and learning working space was an environment using Courselab. Its interface was divided into the following four frames to facilitate the working area definition for each service (see Figure 9.9):

- The frame on the right (number 4 in Figure 9.9) displays the main working window of the environment (learning contents, tasks, etc.).
- The frame on the bottom (number 3 in Figure 9.9) displays the general navigation tool bar of the environment.
- The name of the topic is shown in frame 1
- The icons of the lesson map , course content and exercise are in frame 2

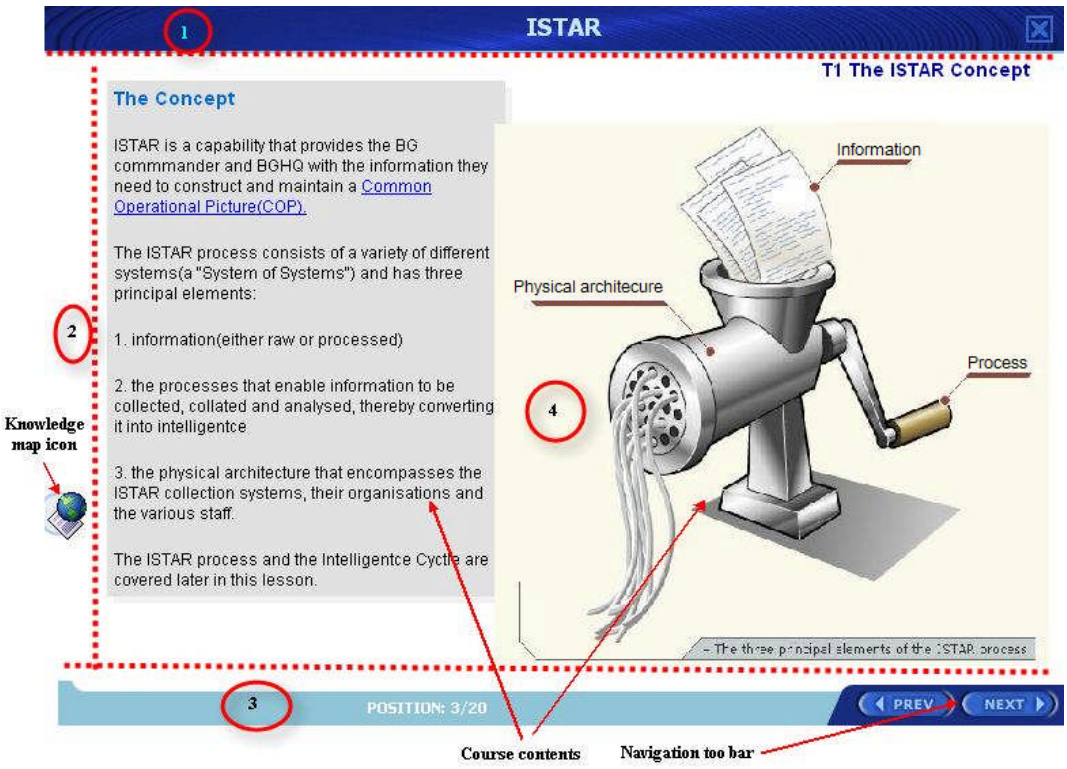


Figure 9.9: Aspects of the KTABAE working space

In addition, the whole course design still follows the first principles of this research in KTABAE. They are:

- A description of desired learning outcomes;
- A specification of course content;
- Learning activities to be employed;

- The assessment strategy to be used.

The working scenario of the KTABAE system is defined by the type of users and the type of the content offered. If the working environment is an adaptive hypermedia system for education, the users are classified as teachers, who prepare and set up the teaching content for adaptive teaching for students who carry out the learning activities in a personalised way. The student model is built by taking into account the student knowledge state obtained by analysing the student actions.

Teachers build the teaching content based on a set of pages that comprise the theoretical definitions (conceptual knowledge and procedural knowledge) using different course designs and media formats (to match Pask and Scott's[116] learning styles for the holist and serialist). Subsequently, using the tools available in Courselab, they proceed to define how these contents should be taught (domain model building), in which case they build the concept structure and the relationships between the tasks. Finally, this knowledge is stored in the system database. The student carries out the learning activities in a pleasant and assisted environment through the personalised user interface. The following figure 9.10 shows this working scenario.

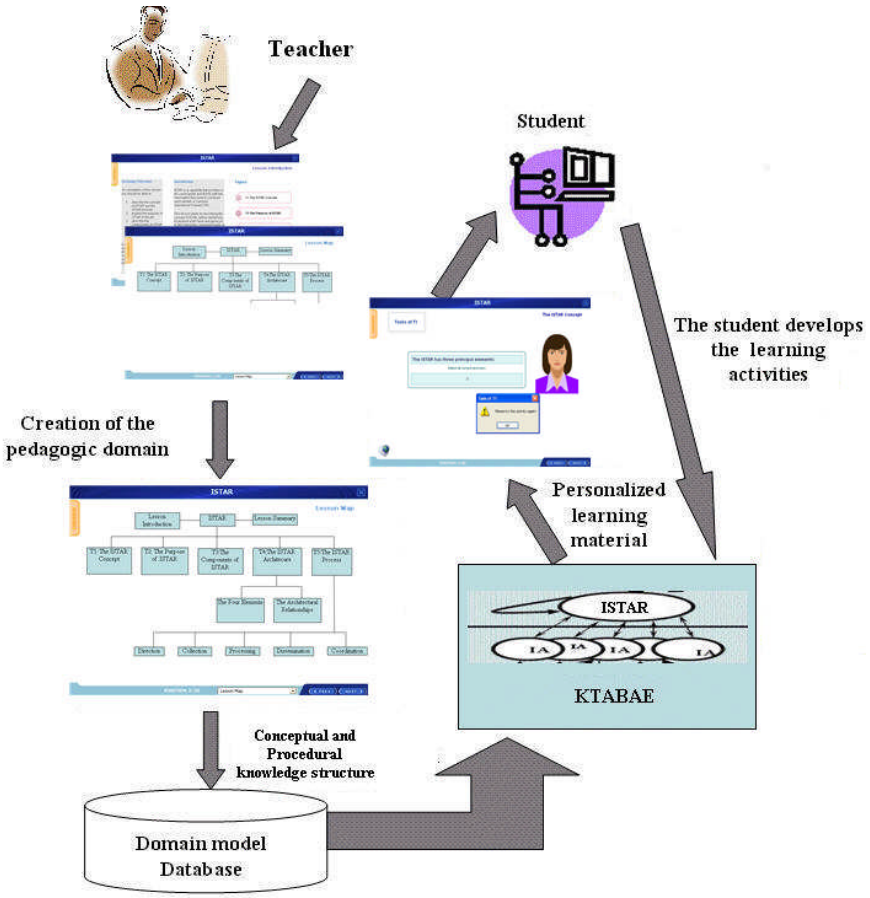


Figure 9.10: KTABAE working scenario

This chapter has shown the logical and technological solutions proposed for the development of Knowledge and Task Analysis based adaptive environment (KTABAE). The next chapter will present how an experimental study was carried out to evaluate the effectiveness of KTABAE.

10 EXPERIMENTATION AND EVALUATION OF KTABAE

A case study has been used to explore how KTABAE is employed in MK courses. The scale of the study was quite small as it used only a small part of one of the MK courses and a small sample of subjects. Part of the research was concerned with finding a way to implement adaptive teaching using today's technology. One MK lesson (ISTAR) was subject to a detailed Knowledge and Task analysis, more detailed than in the original course design work.

For the evaluation study, four versions of the lesson were prepared, using two independent variables: (i) with or without adaptive sequencing rules (ii) with or without access to a lesson map to aid navigation.

The research questions are:

1) Will learning with lesson maps and adaptive teaching lead to better learning performance?

2) Will learning performance of the groups with adaptive teachings be better than the groups without adaptive sequences?

3) Will learning performance of the groups with lesson maps be better than the groups without lesson maps?

4) Will students' attitudes toward the use of lesson maps and adaptive teaching tend to be positive?

10.1 Experimental design

The respondents of the present study were 32 undergraduate students, who were spread over different departments of the University of East Anglia. The content of this experimental instruction was from one lesson of MK. None the respondents had any prior knowledge about it. Moreover, it was assigned to each participant of the four different groups at random. Thus, this study randomly assigned each participant to one of four instructional treatments- lesson map-aided adaptive teaching group, lesson map-aided non adaptive teaching group, non lesson map-aided adaptive teaching group and non lesson map-aided non adaptive teaching group to carry out the instructional experiment. The distribution of the number of respondents in each experimental group is shown in Table 10.1 below.

Table 10.1: The distribution of the number of respondents in each group

	Adaptive teaching	Non adaptive teaching	Total
Lesson map aided	8	8	16
Non lesson map aided	8	8	16
Total	16	16	32

A 2 × 2 experimental design was used to investigate the research questions. The first independent variable, type of lesson map, consisted of lesson map aided learning and no lesson map aided learning, which is described in the following:

- Lesson map aided learning, in which a lesson map was designed for learners navigation and to apply the preferred learning strategies necessary to learn.

  According to Pask and Scott[116], there are two main strategies for students to use learning materials. One is a holist strategy and the other is a serialist strategy. The students who use a holist strategy prefer to access many "topics" (chunks of learning material), so they can build up an overview of the subject matter. After that, they may attend to a specific topic.

  On the other side are students who use a serialist strategy, that is working in a one-step-at-once manner. They will not access further topics until they learn the details of a particular topic. Subject matter topics are presented on ISTAR in a way that supports holist or serialist strategy.

- No lesson map aided learning, in which a hierarchy-oriented fixed learning sequence was imposed. This meant that the subordinate or lower-order skills were a prerequisite for learning the superordinate or higher-order skills.

The second independent variable, type of learning sequence, consisted of an adaptive teaching sequence and a procedural learning sequence, these are described in the following:

- For the adaptive teaching group, learners had to successfully complete the learning task for a topic before proceeding to the next topic. If the learner did not pass the task, the adaptive teaching directed the learner back to the last topic in order to correct the learner's errors and misunderstandings. If the learner passed the task successfully, they could (if available) use the lesson map to select the next topic. Otherwise, they were presented with the next topic in the imposed teaching sequence.

- For the non adaptive teaching group, learners did not have to successfully complete the learning task for a topic before proceeding to the next topic. If the lesson map was available, they could freely choose the next topic. Otherwise, they were presented with the next topic in the imposed teaching sequence.

Before	**Experimental Instruction (Independent variables)**	**After (Dependent variables)**

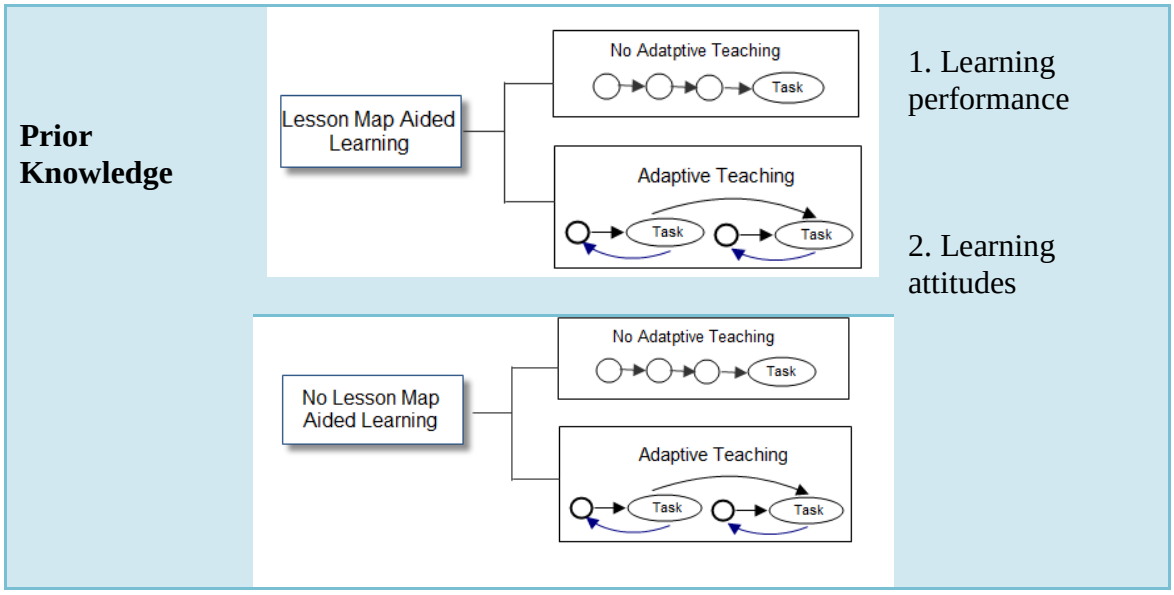


Figure 10.1: The experimental of the present study

With regards to the purpose of the present study, the dependent variables were students' performance in ISTAR learning and attitudes toward the KTABAE instruction. Learning performance – the scores of multiple-choice questions and field-blank questions on the ISTAR achievement test – represented the learning performance of the knowledge. For students' attitudes, there were three dimensions to be explored: (1) the acceptability of the KTABAE instruction, (2) the easy manipulation of the KTABAE instruction, and (3) the helpfulness of the KTABAE instruction in learning.

10.2 Experiment instruments

In order to investigate the effects of lesson map and adaptive teaching on students' learning performance in ISTAR and their attitudes toward the KTABAE instruction, the present study used three research instruments for the instructional experiment. This included the four types of ISTAR instruction, the ISTAR achievement test and the learning attitudes questionnaire. All of these instruments are specified in the following.

- The Four Types of ISTAR Structure Instruction

The domain knowledge of the present study was ISTAR. This instruction was presented in the form of pages that were designed by the researcher by using Courselab (see figure 10.2). The course design process followed Pask and Scott's[117] CT theory of first principles that is informing the learner of about learning outcomes, presenting stimulus material, providing learner activities, implementing teaching strategies and assessing performance .

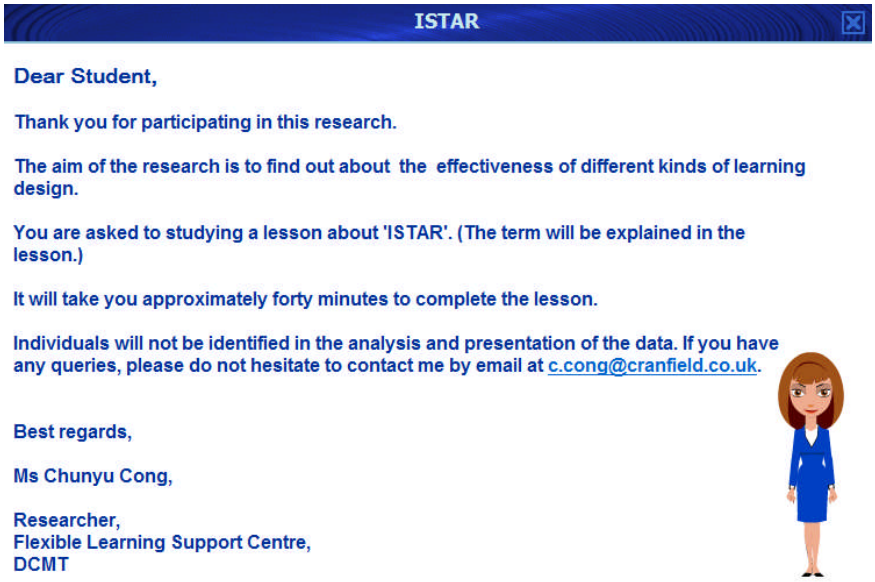


Figure 10.2 : The instructions of the lesson

According to the research design, this part of the study was aimed at evaluating the lesson map and the adaptive sequence to create four types of experimental instruction for each experimental group, they are as follows: lesson map aided learning strategy, lesson map aided adaptive teaching and lesson map aided non-adaptive teaching; for non- lesson map aided learning strategy, there were non-lesson map aided adaptive teaching and non-lesson map aided non adaptive teaching.

- The ISTAR Achievement Test

The purpose of the ISTAR achievement test was to evaluate students' learning performance after they finished the experimental instruction of ISTAR. The domain of the ISTAR achievement test, as shown as figure10.3, was set in accordance with the content of the lesson.

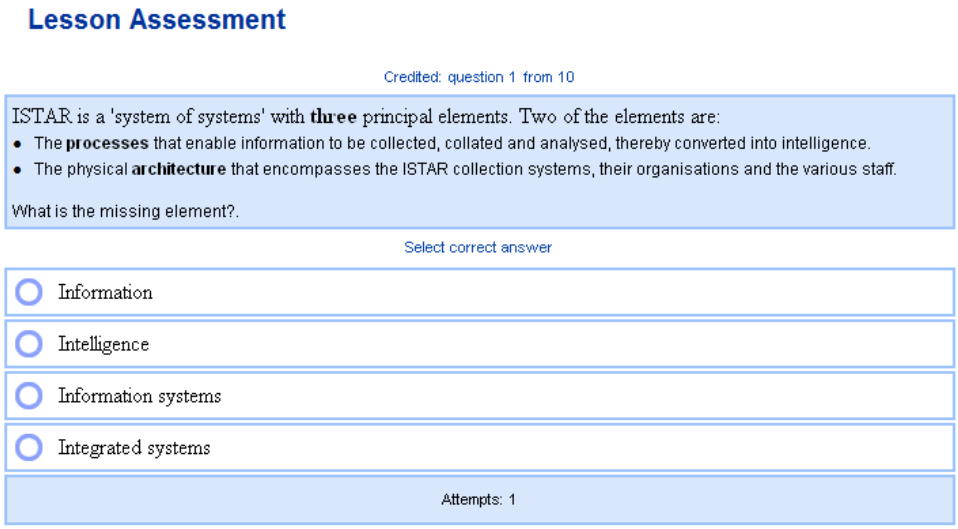


Figure 10.3: The achievement test

- The Learning Attitudes Questionnaire

The purpose of the learning attitudes questionnaire was to investigate respondents' attitudes towards adaptive teaching and the lesson map of ISTAR. The items of the learning attitudes questionnaire were set by the researcher, and consisted of three sections, including (1) the acceptability of the adaptive instruction, (2) the easy manipulation of the instructions for studying, (3) the helpfulness of the learning tasks in learning, and (4) the usefulness of the lesson map. There are two sets of the questionnaire for the lesson map assisted groups and the adaptive teaching groups. All the questions for both sets are the same apart from two questions which are about the lesson map and the learning tasks of adaptive teaching. The questionnaires are shown in Appendix I and G.

10.3 Experimental procedure

Before the experiment, the researcher spent 5 minutes giving guidelines regarding the manner and the length of the instruction to respondents before beginning the learning in this study. During the experimental instruction, respondents accessed the different ISTAR instructions and engaged in different learning activities in accordance with the group that they respectively belonged to.

After the instruction, all of the respondents had an ISTAR achievement test (15 minutes) and a questionnaire survey (5 minutes) for investigating their learning performance and attitudes. The flowchart of this four-week learning activity is illustrated as Figure 10.2.

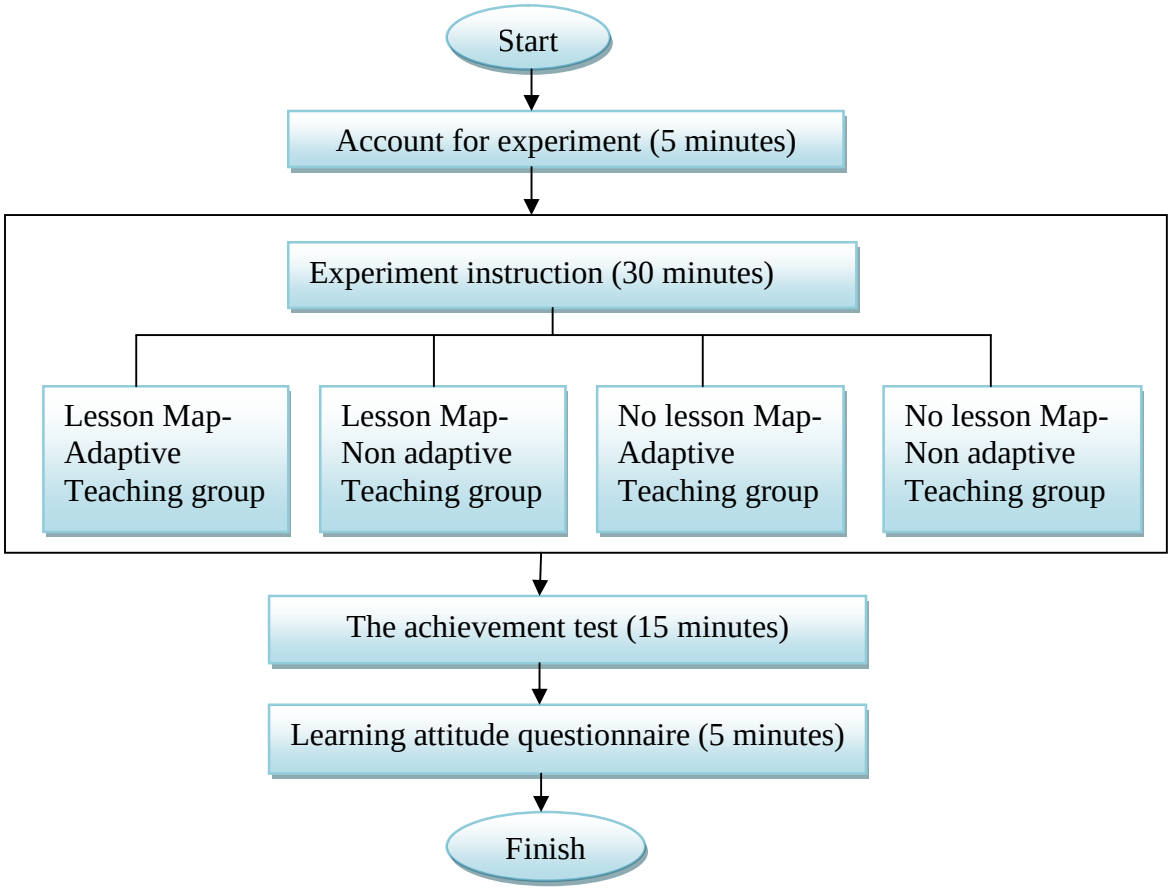


Figure 10.4: Flowchart of the instructional experiment

10.4 Data analysis

The data collected in this presented study were analysed with SPSS 16.0 statistical software. Detailed description of the presented data analysis is described in the following section.

10.4.1 The analysis of learning performance

For the analysis of learning performance, the present study used two-way ANOVAs. The type of lesson map and the type of adaptive sequence were independent variables. The performance of the ISTAR achievement test was the dependent variables. The mean scores, standard deviations of the performance on the ISTAR achievement test and the number of respondents in each experimental group are shown in Table 10.2. Figure 10.5 shows the comparison of the performance among the four groups.

Table 10.2: Means, standard deviations and number of respondents on performance

	N	Minimum	Maximum	Mean	Std. Deviation
Lesson Map-Adaptive	8	81	93	88.00	3.891

Teaching					
Lesson Map-Non adaptive Teaching	8	65	85	75.62	7.090
No lesson Map-Adaptive Teaching	8	80	91	85.62	3.701
No lesson Map-Non adaptive Teaching	8	60	77	69.25	5.339
Valid N (listwise)	8				

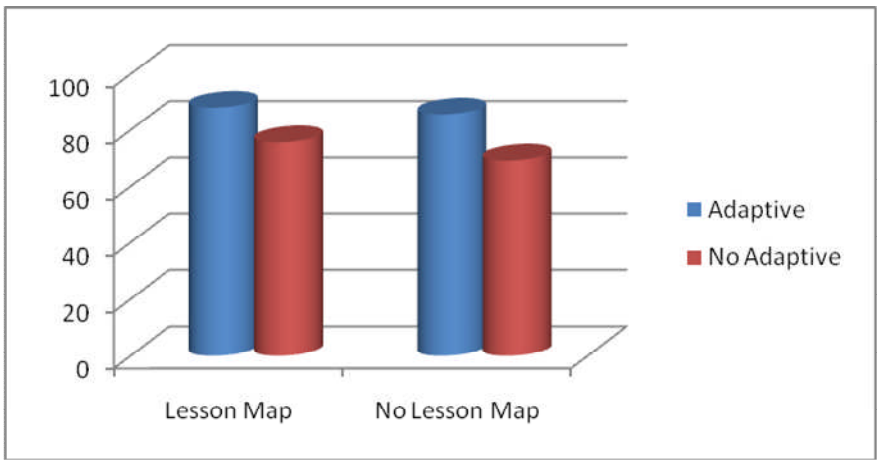


Figure 10.5: The differences of performance within four groups

The research question examined the effects of the lesson map and the adaptive sequence on performance. The results of the ANOVA are shown in Table 10.3.

Table 10.3: Analysis of variance for performance

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1817.594a	3	605.865	22.510	.000
Intercept	203043.781	1	203043.781	7.544E3	.000
Adaptive Teaching	1638.781	1	1638.781	60.887	.000
Lesson Map	148.781	1	148.781	5.528	.026
Adaptive Teaching *	30.031	1	30.031	1.116	.300

Lesson Map			
Error	753.625	28	26.915
Total	205615.000	32	
Corrected Total	2571.219	31	

a. R Squared = .707 (Adjusted R Squared = .675)

- *The Analysis of the Simple Main Effects of adaptive teaching on Performance*

As Table 10.3 illustrates there was significant difference at the one percent level for the simple main effect of adaptive teaching on performance for both the lesson map assisted and no lesson map assisted groups, $F(1,32) = 60.887$, $p<0.01$. The adaptive teaching groups had a better performance than the non adaptive teaching groups.

- *The Analysis of the Simple Main Effects of the Lesson map on Performance*

As shown in Table 10.3, there was a significant difference at the five percent level for the simple main effect of the lesson map on performance for both the adaptive teaching group and non adaptive teaching groups, $F(1,32) = 5.528$, $p<0.05$. The lesson map assisted groups had better performance than no lesson map assisted groups.

- *The Analysis of the Interaction of Lesson Map and Adaptive Teaching*

As Table 10.3 shows, the interaction of lesson map and adaptive teaching was not significant, F (1, 32) = 1.116. The interaction of lesson map and adaptive teaching is shown as Figure 10.6. There is some indication that the lesson map was marginally more helpful for the non adaptive group.

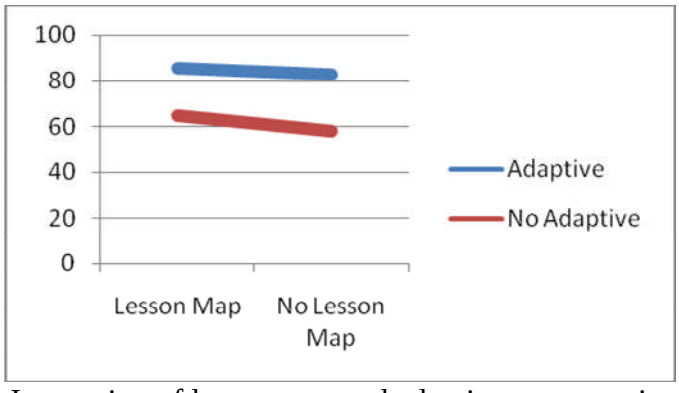


Figure 10.6: Interaction of lesson map and adaptive sequence in performance

10.4.2 The analyses of learning attitudes

The questionnaire of learning attitudes used the 5-point Likert Scale to evaluate whether the ISTAR instruction in the present study was accepted by students; whether this ISTAR instruction was easy to manipulate; whether the learning tasks were helpful to students in learning; how often the learning tasks were used by students in adaptive teaching groups; finally, whether the lesson map was useful. At the end of the questionnaire, there was an open-ended question to ask learners for their opinions and suggestions about this experimental instruction.

- *The Analysis of the Acceptability of the ISTAR Instruction*

There were 4 items in total about the acceptability of this instructional material.

- How enjoyable was your learning experience?
- I enjoyed being allowed to study at my own pace.
- I liked to use this kind of design of learning material.
- I would like to use a similar design of learning material, if there are chances to do e-learning courses in the future.

Each item was valued on a scale of 1 to 5 where 3 is neutral. The higher the score, the more acceptability. Table 10.4 shows the mean scores, standard deviations, and the number of respondents in each group.

Table 10.4: Means, standard deviations, and number of respondents for acceptability

	N	Mean	Std. Deviation
Lesson Map-Adaptive Teaching	32	4.7188	.45680
Lesson Map-Non adaptive Teaching	32	2.6875	.78030
No lesson Map-Adaptive Teaching	32	3.6250	.70711
No lesson Map-Non adaptive Teaching	32	1.2188	.49084
Valid N (listwise)	32		

The results of the ANOVA are reported in Table 10.5. The results reveal that there was no significant interaction between the lesson map and adaptive sequences, $F(1,128) = 2.887$, $p = .092$. For the main effect of the lesson map, the test was significant, $F(1,128) = 134.828$, $p<.001$, meaning that the lesson map assisted learning indeed aroused the

learners' interest and motivation for learning. Another probable reason may be due to the freedom of learning control. The lesson map assisted group could select any item of instructional material at their own choice, yet the reading procedure of the no lesson map assisted group was restricted. So the lesson map assisted group accepts this kind of instructional material more than the no lesson map assisted group.

For the main effect of the adaptive sequence, the test was significant, $F(1,128) = 404.323$, $p<.001$, meaning that the adaptive sequences group were more accepted by learners. The probable reason was inferred that the arranged sequence of instructional materials was different between the adaptive teaching group and the non adaptive teaching group. More feedbacks are provided in the adaptive sequences group. So the acceptability of this instructional material was significantly different.

Table 10.5: Analysis of variance for the acceptability of instruction

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	211.188a	3	70.396	180.680	.000
Intercept	1200.500	1	1200.500	3.081E3	.000
Adaptive Teaching	157.531	1	157.531	404.323	.000
Lesson Map	52.531	1	52.531	134.828	.000
Adaptive Teaching * Lesson Map	1.125	1	1.125	2.887	.092
Error	48.312	124	.390		
Total	1460.000	128			
Corrected Total	259.500	127			

a. R Squared = .814 (Adjusted R Squared = .809)

- The Analysis of the Ease of Manipulation of the ISTAR Instruction

There is one item about the easy manipulation of instructional material. The item was valued on a scale of 1 to 5 where 3 is neutral. The higher the score, the more easy the manipulation. Table 10.6 shows mean scores, standard deviations, and the number of respondents in each group.

- How easy was it to follow the instructions for working through the tasks?

Table 10.6: Means, standard deviations, and number of respondents on the easy manipulation

	N	Mean	Std. Deviation
Lesson Map-Adaptive Teaching	8	4.3750	.51755
Lesson Map-Non adaptive Teaching	8	2.5000	.53452
No lesson Map-Adaptive Teaching	8	3.6250	.51755
No lesson Map-Non adaptive Teaching	8	1.3750	.51755
Valid N (listwise)	8		

The results of ANOVA are shown as Table 10.7 and reveal that there was no significant interaction of lesson map and adaptive sequence, $F(1,32) = 1.033$, $p = .318$. For the main effect of the lesson map, the test was significant, $F(1,32) = 124.976$, $p<.001$. The probable reason was that the navigational buttons for the group with the assisted learning map were clear making the learning material easy to navigate. Because of this navigational device, the learners using the lesson map could manipulate the learning material more easily and accurately move to the page he/she wanted to read.

Table 10.7: Analyses of variance for the ease of manipulation of instruction

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	41.344a	3	13.781	50.607	.000
Intercept	282.031	1	282.031	1.036E3	.000
Adaptive Teaching	7.031	1	7.031	25.820	.000
Lesson Map	34.031	1	34.031	124.967	.000
Adaptive Teaching * Lesson Map	.281	1	.281	1.033	.318
Error	7.625	28	.272		
Total	331.000	32			

Corrected Total	48.969	31

a. R Squared = .844 (Adjusted R Squared = .828)

For the main effect of the adaptive sequence, the test was significant, F (1, 32) = 124.967 p = .000. The probable reason was that the arranged sequence of instructional materials was different between the adaptive teaching group and the non adaptive teaching group, making the learning content much easier to follow in adaptive teaching.

- The Analysis of the Helpfulness of the Learning tasks

There was one item exploring the helpfulness of the ISTAR instructional material in learning.

- How helpful were the learning tasks in helping to learn about ISTAR?

Each item was valued on a scale of 1 to 5 where 3 is neutral. The higher the score, the more helpful the learning tasks. Table 10.8 shows mean scores, standard deviations, and the number of respondents in each group.

Table 10.8: Means, standard deviations, and number of respondents on the helpfulness of the learning tasks

	N	Mean	Std. Deviation
Lesson Map-Adaptive Teaching	8	4.3750	.74402
Lesson Map-No Adaptive Teaching	8	3.6250	.51755
No lesson Map-Adaptive Teaching	8	3.5000	.53452
No lesson Map-Non adaptive Teaching	8	3.0000	1.06904
Valid N (listwise)	8		

The results of the means reveal that all four groups of students had positive opinions about the helpfulness of the learning tasks, especially the lesson map and adaptive teaching group who had the highest mean at 4.375.The probable reason is that they can get feedback from the learning tasks they were doing.

- The Analysis of the frequency of use of the learning tasks.

Here follows one item about the frequency of use of the lesson tasks. The item was valued on a scale of 1 to 5 where 3 is neutral. The higher the score, the more frequent the use of the learning tasks. Table 10.9 shows mean scores, standard deviations, and the number of respondents in each group.

- How frequently did you access to the learning tasks?

Table 10.9: Means, standard deviations, and number of respondents on the frequency of the use of the learning tasks

	N	Mean	Std. Deviation
Lesson Map-Adaptive Teaching	8	4.3750	.51755
Lesson Map-Non adaptive Teaching	8	3.2500	.46291
No lesson Map-Adaptive Teaching	8	2.5000	.53452
No lesson Map-Non adaptive Teaching	8	1.0000	.00000
Valid N (listwise)	8		

From the result of the means, the learning tasks were most used in the lesson map-adaptive teaching group. Lesson map-Non adaptive teaching group was the second most often to use the learning task. The reason was that the students could use the lesson map to navigate to the task that they wanted to do.

- The Analysis of the Usefulness of the Learning Map.

There was one item about the usefulness of the lesson map. The item was valued on a scale of 1 to 5 where 3 is neutral. The higher the score, the more useful was the lesson map. Table 10.10 shows mean scores, standard deviations, and the number of respondents in each group.

- How useful was it to have the Lesson Map as a way of navigating through the course?

Table 10.10: Means, standard deviations, and number of respondents on the usefulness of the lesson map

	N	Mean	Std.

			Deviation
Lesson Map-Adaptive Teaching	8	4.7500	.46291
Lesson Map-Non adaptive Teaching	8	4.3750	.51755
Valid N (listwise)	8		

Thus, in the students' thoughts, they considered that the lesson map assisted learning was useful in learning. The means of both groups were very high. The probable reason for this result is that the lesson map can be a useful navigation tool and a more flexible learning environment for the student.

10.5 Conclusions

The purpose of this part of the study was to investigate the effects of adaptive teaching and the lesson map on students' learning performance and attitudes toward the instruction. According to the analysis of the results of the instructional experiment, in the next section the researcher makes some suggestions in this section for future research.

Through the analysis, two main conclusions were generated: (1) the learners could efficiently achieve high performance by adaptive teaching; (3) the learners' attitudes were influenced by the adaptive teaching and the lesson map. These conclusions also answer the research questions of this part of the study, which are (1) will the learning with lesson maps and adaptive sequences lead to better learning performance? (2) Will the learning performance of the groups with adaptive sequences be better than the groups without adaptive sequences? (3) will the learning performance of the groups with lesson maps be better than the groups without lesson maps? (4)Will students' attitudes toward the use of lesson maps and adaptive sequences tend to be positive?

The specific meaning and the probable reasons of these conclusions will be described in turn as follows.

a. The learners could efficiently achieve high performance by adaptive teaching

The results shows there was significant difference of the simple main effect of the adaptive teaching on performance for the lesson map assisted and no lesson map assisted group. The main effects of lesson map were not significant. And the interaction of lesson map and adaptive teaching was not significant too.

In terms of the lesson map, there were no significant effects on the performance of the learning and the probable reason was that the tasks were analysed by methodology of knowledge and task analysis, and were provided with fairly explicit knowledge such

that the students may be in a state of receiving the clear knowledge. It also could prove the previous researches that learning styles of students are mostly serialist.

b. The learners' attitudes were influenced by the adaptive teaching and lesson map

In terms of the learning attitudes, the learners held neutral or comparatively negative opinions toward the instruction without adaptive teaching and lesson map on the average. Only when using adaptive teaching and lesson map as the strategy did the majority of learners hold comparatively positive attitudes.

From the conclusions described above, it is perceived that the development of the researches for Knowledge and Task Analysis based adaptive teaching can proceed further.

11 CONCLUSIONS AND FUTURE WORK

The existing problems of course design for RBL give cause for concern and are widely discussed. Course designers have been challenged to design high quality courses for students. In this research, we proposed an approach from first principles for course design, based on CT.

CT also provided us with a methodology to achieve an interactive learning and teaching environment that is based on the Knowledge and Task Analysis methodology. Therefore, the purpose of this study was aimed at the following:

- Investigation of students' perceptions of a conversational RBL environment.
- Investigating students' attitudes toward the above approach to course design.
- Investigating the effectiveness of lesson maps and adaptive teaching.
- Investigating students' attitudes towards lesson maps and adaptive teaching.

In the literature review, an overview of the theories and research on which the course design and adaptive teaching approaches for RBL are based was presented. The approach is fundamentally based on the integration of three cornerstones, which are:

- The basic conception of RBL
- Traditional and current learning theories and methods that are compared with CT for providing the theoretical basis of course design for RBL.
- Knowledge and task analysis acting as the main vehicle or tool in achieving the effective adaptive teaching designs.

Basic principles and the most relevant aspects of each of these cornerstones were elaborated and presented in the thesis to provide the reader with the necessary background information. Then a principled approach to course design was presented as one of main contributions of this work. The course design description was explained in detail by presenting the course design model. The approach was embedded into a novel conceptual framework guiding the integrated application of CT.

An interactive approach to RBL was presented that is based on the Knowledge and Task Analysis methodology. The real strength of the adaptive teaching approach was shown to lie in the dedicated focus on one consistent theoretically and practically founded pedagogical baseline, the utilization of knowledge and task analysis-oriented and lesson map techniques to support learning processes.

To show the applicability and usefulness of the principled approach to course design and the adaptive teaching environment framework, three case studies were presented in this thesis.

11.1 Conclusions of the course design for RBL

Guided by the research questions aforementioned in chapter one for the research of course design, the main purpose of quantitative and qualitative research was to explore whether or not the course design was effective and whether or not students were satisfied with this kind of course design. Methods, including field observations and in-depth interviews, were used to collect the data according to the research questions guiding this study. Major findings were as follows:

Research Question 1: Are students satisfied with this kind of course design?
Research Question 2: What are students' perceptions of the features of the course design?

- learning outcomes of course design
- Knowledge map and Lesson maps
- Learning designs using activities
- Lesson assessments
- Summaries

These two questions were answered from the questionnaires about the MK and Online Master Programme and the interviews about MK.

Students' responses to the evaluation questionnaires of MK and the questionnaire of Online Master Programme were analysed from the aspects of the features of course design. The results showed the students mostly held a positive attitude toward MK courses and Online Master Programme and the features of the course design. They believed that the courses could facilitate their learning of Military knowledge. From the first part of the research questions we can see it is well supported that students in general perceived MK and Online Master coursed positively. Students gave positive feedback on this kind of course design in terms of the design of learning outcomes, knowledge and lesson maps, learning design, lesson summaries and lesson assessments.

The in-depth interviews were also used to collect data about these two research questions. On the whole, the data from the respondents reflected that they were satisfied with the course design of MK and its main features.

Research Question 3: What variables affected the perspectives of students about the courses?

From the interview results, the following variables were found to affect the perspectives of students in the courses.

- e-Learning experience backgrounds
- IT skills
- Situations of study
- An internet connection
- Learner's learning style preference

- Learner's study time
- VLE or CD
- Learner's motivation to learn

Research Question 4: How do students respond to and interact with the courses?

The researcher observed and video recorded how students responded to and interacted with MK courses. After organising and decoding the data, the researcher classified five interaction features that corresponded to some of the basic principles of Course Design proposed by this research. Through the five interaction features, i.e., learning outcomes clarification, reading through the knowledge map, working on lesson activities, reading through summaries, and working on lesson assessments, students' positive motivation and learning efficiency were enhanced.

Finally, the other main finding of this research is the respondents' diverse learning styles. The result of the investigation of learning style showed that most of respondents, who are respectively serialists, tended to learn the subject topics step by step. On the other hand, several respondents were holists who were inclined to learn the subject topics as a whole.

11.2 Conclusions concerning adaptive teaching

Various aspects concerning adaptive teaching have been presented. They include some pedagogical and technological aspects which have been investigated in this part of the work. The main motivation in proposing the KTABAE architecture and methodology was the need to offer students the adaptive teaching best suited to their individual learning profile. This was achieved using adaptivity in combination with a lesson map.

In achieving the proposed objectives of adaptivity, the methodology of Knowledge and Task Analysis has been successfully applied. The conceptual model of the proposed adaptive system is based on a standard architecture which includes the learning module, domain module and diagnosis module. In conclusion, the main features of the KTABAE can be summarised as follows:

- The Knowledge and Task Analysis-Based Adaptive teaching Sequence Construction rules are used to generate adaptive teaching sequences for students to solve students' encountered problems.

- Students can access their study material through an adaptive environment. In particular, the lesson map was a good way to assist and navigate them during their learning process.

For the evaluation study of adaptive teaching, four versions of the lesson were prepared, using two independent variables: (i) with or without adaptive sequencing rules (ii) with or without access to a lesson map to aid navigation. The following research questions were answered.

- Will the learning with lesson maps and adaptive sequences lead to better learning performance?
- Will the learning performance of the groups with adaptive sequences be better than the groups without adaptive sequences?
- Will the learning performance of the groups with lesson maps be better than the groups without lesson maps?
- Will students' attitudes toward the use of lesson maps and adaptive sequences tend to be positive?

With regard to the students' behaviour and attitude of experimentation results, the main conclusions are:

- The adaptive teaching groups had a tendency to have better performance than non adaptive teaching groups.
- The lesson map assisted groups had a tendency to have better performance than no lesson map assisted groups.
- The lesson map did not influence adaptive teaching on the performance.
- The lesson map assisted group accepted this kind of instructional material more readily than the no lesson map assisted group.
- The adaptive teaching group accepted their kind of instructional material more than the non adaptive teaching group.

11.3 Future work

The recommendations below are for the course design of RBL and adaptive teaching based on CT. These recommendations have been derived from the literature review, the theoretical design, experimentation and the conclusions presented in the previous chapters. More specific suggestions to do with the MK courses and the MMP programmes will in due course be shared with the course leaders.

- Computer-Mediated Communication in the course design

Based on the research findings, the principles of the course design for RBL seemed to be welcomed by different learning-style and individual-background students. Most of the learners implied that RBL should be the main access to knowledge and that traditional methods would be best used to discuss any issues or problems with a lecturer. In other words, some traditional types of activities should be incorporated, such as discussion, experience sharing, practical insights, and so on. This would create a collaborative learning environment making each student involved in the learning. Computer-mediated communication (CMC) activities can be constructed. Teachers may set up web-based bulletin boards, discussion forums, and various kinds of chat rooms to

facilitate online communication. Learners can be engaged in small group discussions or be connected with global learners for focused discussions on concrete topics. Discussions can take place before learning activities begin when students are predicting the results of the activities. They can also take place during learning activities when students draw knowledge from experts, also after the activities when students share and reflect upon their learning experiences. In conclusion, in future course design, teachers can take advantage of CMC to create an interactive but stress-free environment for students. Within this environment, students, especially less proficient learners, can increase the scaffolding of their learning through peer sharing of comments and negotiation of meaning among peers.

- Based on KTABAE, some improvements and new features have been envisaged.

Most of them can be carried out with no (or minor) modifications to the proposed system architecture of knowledge and task analysis. The course design of the present study still needs to be improved. Thus, the researcher has provided the following suggestions for future research on adaptive teaching.

a. Adding a forum to the computer-assisted instructional system

Regardless of the adaptive teaching strategy, learners should integrate and apply knowledge relying on the guided tasks and the cooperative learning context. Through discussion and mutual help, learners could solve problems, complete the task, and learn from it. This shows that cooperation is a necessary segment in the process of task accomplishment and problem-solving. Therefore, the researcher proposes adding a forum to the adaptive teaching system for students to interchange ideas and share information. This could enable them to learn faster and be more efficiently.

b. The learning module can be enlarged with new features.

For instance, an additional, new function such as a notebook could be used. This would allow students to manage their own notes and also be linked with the system content and structure: let's say an “intelligent notebook”. Teachers would also benefit from these “new assistants” by helping them to keep accurate information about students’ progress and behaviour. This would be carried out automatically with little or no effort on the part of the teacher. This would include presentation, in graphs, charts, etc., of learning behaviour and tendencies. A continuous assessment of the learning process can also be improved by adding new types of exercises. As on-line communication tools improve, teachers could provide additional explanations about the most difficult points through a shared whiteboard.

c. Adaptive teaching with topic maps could be used to support multi-tasking in a learning environment, for example, by permitting learners to have more than one topic ‘active’ at any one time. This would be particularly useful for holist learners, as demonstrated by Pask and Scott’s studies using CASTE.[119]

In short, it is also desirable to widen the range of experimentation with larger numbers of regular courses, students and didactic units (specifically redesigned for such adaptive environments).

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BIBLIOGRAPHY

Adaptive teaching

Adaptive teaching is a type of instruction that supplies alternative teaching operations based on assessment of student readiness to profit from them.

ANOVA

In statistics, analysis of variance (ANOVA) is a collection of statistical models, and their associated procedures, in which the observed variance is partitioned into components due to different explanatory variables.

Cognition

Cognition is the mental process of knowing, including aspects such as awareness, perception, reasoning, and judgment.

Course design

Course Design is the systematic approach to the development of instructional programs which takes into account learning theory and research to ensure that the intended learning aims are realized.

Distance learning

Distance learning is learning while at a distance from one's teacher - usually with the help of pre-recorded, packaged learning materials.

Educational Technology

“Educational technology is a systematic way of designing, implementing and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communication and employing a combination of human and non-human resources to bring about more effective instruction” (Commission on Instructional Technology, USA)

e-Learning

The delivery of a learning, training or education program by electronic means. e-Learning involves the use of a computer or electronic device (e.g., a mobile phone) in some way to provide training, educational or learning material.

Feedback

Feedback is information which can be used to restructure knowledge and support the metacognitive regulation of ongoing performance.

Formative assessment

Formative assessment is an assessment tool utilized to gain information that will guide further instruction.

F-test

An F-test is any statistical test in which the test statistic has an F-distribution if the null hypothesis is true.

ISTAR

ISTAR stands for Intelligence, Surveillance, Target Acquisition, and Reconnaissance. In its macroscopic sense, ISTAR is a practice that links several battlefield functions together to assist a combat force in employing its sensors and managing the information they gather.

Learning design

Learning design is the practice of creating instructional tools and content to help facilitate learning most effectively

Learning Management System (LMS)

A Learning Management System is a software package used to administer one or more courses to one or more learners. An LMS is typically a web based system that allows learners to authenticate themselves, register for courses, complete courses and take assessments.

Learning object

Learning Object is a discrete “chunk” of data that is part of a learning module. It can include video, audio, text, email, slides, case studies, or any medium that can be digitized. It includes the content of the course and the medium by which content is delivered in an online environment.

Learning platform (LP)

A learning platform (LP) is the entirety of tools and software to organize and facilitate Web-supported learning.

Learning styles

Learning styles refer to the cognitive, affective, and physiological factors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment.

Learning theory

Learning as a process focuses in what happens when the learning takes place. Explanations of what happens are called learning theories. A learning theory is an attempt to describe how people and animals learning; thereby helping us understand the inherently complex process of learning.

Likert scale

A Likert scale is a psychometric scale commonly used in questionnaires, and is the most widely used scale in survey research. When responding to a Likert questionnaire item, respondents specify their level of agreement to a statement.

Main Effect

In the design of experiments and analysis of variance, a main effect is the effect of an independent variable on a dependent variable averaging across the levels of any other independent variables.

Means

For a data set, the mean is the sum of the observations divided by the number of observations.

Metacognition

Metacognition - thinking about thinking - is the ability of learners to plan, monitor, and control their own cognitive processes and performance, and to select learning strategies for themselves. It refers to awareness of one’s own knowledge and the ability to understand and manipulate cognitive processes.

Multimedia

Multimedia is media and content that utilizes a combination of different content forms.

Open learning

An open learning system is one that puts the individual learner at the centre of things.

Pedagogy

Pedagogy is the study of teaching.

P-value

In statistical hypothesis testing, the p-value is the probability of obtaining a result at least as extreme as the one that was actually observed, given that the null hypothesis is true. The fact that p-values are based on this assumption is crucial to their correct interpretation.

Qualitative research

Qualitative research is used to gain insight into people's attitudes, behaviours, value systems, concerns, motivations, aspirations, culture or lifestyles

Quantitative research

Quantitative research is used to measure how many people feel, think or act in a particular way.

SCORM

SCORM stands for Sharable Courseware Object Reference Model. SCORM compliance is the design standards that learning objects follow to ensure transferability and reusability.

SPSS

SPSS is a computer program used for statistical analysis.

Standard deviation

In statistics, standard deviation is a simple measure of the variability of a data set. A low standard deviation indicates that all of the data points are very close to the same value (the mean), while high standard deviation indicates that the data are “spread out” over a large range of values.

Statistical significance

In statistics, a result is called statistically significant if it is unlikely to have occurred by chance. "A statistically significant difference" simply means there is statistical evidence that there is a difference.

Subject Matter Expert

A Subject Matter Expert (SME) is a person who is an expert in a particular area. In software engineering environments, the term is used to describe professionals with expertise in the field of application but without technical project knowledge.

Summative assessment

Summative assessment is an assessment tool utilized to determine final learning outcomes and often to determine grades.

SWOT analysis

SWOT Analysis is a strategic planning method used to evaluate the Strengths, Weaknesses, Opportunities, and Threats involved in a project or in a business venture.

APPENDICES

APPENDIX A: THE SHORT QUESTIONNAIRE EVALUATION OF MK COURSES

May – Aug 06

	MK2 YES	MK2 NO		MK1 YES	MK1 NO		TOTAL MK1&2 YES	TOTAL MK1&2 NO
Was the content relevant for the learning outcomes?	1139	63	**Was the content relevant for the learning outcomes?**	2246	154	**Was the content relevant for the learning outcomes?**	3385	217
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**
Was the content the correct difficulty level?	949	255	**Was the content the correct difficulty level?**	2128	272	**Was the content the correct difficulty level?**	3077	527
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**
Was the content accurate?	961	244	**Was the content accurate?**	2157	243	**Was the content accurate?**	3118	487
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**
Was the content up to date?	959	233	**Was the content up to date?**	2300	100	**Was the content up to date?**	3259	333
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**
Did the lessons maintain your interest throughout?	843	352	**Did the lessons maintain your interest throughout?**	2057	343	**Did the lessons maintain your interest throughout?**	2900	695
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**

Did the lessons keep you motivated throughout?	865	330	**Did the lessons keep you motivated throughout?**	2104	307	**Did the lessons keep you motivated throughout?**	2969	637
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**
Were the study times given for the lesson accurate?	481	659	**Were the study times given for the lesson accurate?**	1987	413	**Were the study times given for the lesson accurate?**	2468	1072
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**
Was the language level appropriate?	1167	40	**Was the language level appropriate?**	2346	54	**Was the language level appropriate?**	3513	94
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**
Did the lessons have a flexible learning route?	1075	123	**Did the lessons have a flexible learning route?**	2311	89	**Did the lessons have a flexible learning route?**	3386	212
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**
Was there clear and consistent signposting of where you were?	1085	125	**Was there clear and consistent signposting of where you were?**	2315	85	**Was there clear and consistent signposting of where you were?**	3400	210
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**
Were the activities relevant?	1114	88	**Were the activities relevant?**	2327	73	**Were the activities relevant?**	3441	161
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**

Was the time indicated for the activities accurate?	920	270	**Was the time indicated for the activities accurate?**	2210	190	**Was the time indicated for the activities accurate?**	3130	460
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**
Did you find the activities interesting?	1071	115	**Did you find the activities interesting?**	2252	148	**Did you find the activities interesting?**	3323	263
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**
Did you find the activities reinforcing?	1134	65	**Did you find the activities reinforcing?**	2313	91	**Did you find the activities reinforcing?**	3447	156
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**
Was the feedback for the activities useful?	1132	69	**Was the feedback for the activities useful?**	2324	76	**Was the feedback for the activities useful?**	3456	145
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**
Was the assessment an accurate reflection of your knowledge?	953	246	**Was the assessment an accurate reflection of your knowledge?**	2120	280	**Was the assessment an accurate reflection of your knowledge?**	3073	526
	MK2 YES	**MK2 NO**		**MK1 YES**	**MK1 NO**		**TOTAL MK1&2 YES**	**TOTAL MK1&2 NO**
Was the assessment the correct length?	1001	286	**Was the assessment the correct length?**	2110	290	**Was the assessment the correct length?**	3111	411

APPENDIX B: MK SURVEY

1. Introduction

Dear MK Student,

Thank for visiting the online MK courses survey site.

I am a research student interested in finding out about your experiences of studying the MK courses. In particularly, I am interested in finding out what you think about course presentation and delivery. The findings from my research will help the MK course team make improvements.

It will take you approximately twenty minutes to complete the questionnaire.

Please be assured your response will be strictly confidential. Individuals will not be identified in the analysis and presentation of the data.

If you have any queries, please do not hesitate to contact me by email at c.cong@cranfield.co.uk

Thank you for your participation.

Best regards,

Chunyu Cong (Ms)

2. Demographic Information

1. What is your unit?

2. Do you have other experience with e-learning courses apart from the MK courses?

- ☐ Online training package
- ☐ Online degree courses
- ☐ Open University

Please enter any comments here

3. How would you rate your general IT Skills (PC and Internet)?

- Very Poor
- Poor
- Good
- Very Good

Please enter any comments here

4. What course did you study?

	Completed	Still Studying
MK1	MK1 Completed	Still Studying
MK1 (V)	MK1 (V) Completed	Still Studying
MK2 (a)	MK2 (a) Completed	Still Studying
MK2 (b)	MK2 (b) Completed	Still Studying

5. When did you register to study the MK Course(s)? (An approximate answer will do.)

	DD	MM	YYYY
MK1	MK1 Day	/ Month	/ Year
MK2	MK2 Day	/ Month	/ Year

6. When did you complete your study of MK course(s)? (An approximate answer will do.)

	DD	MM	YYYY
MK1	MK1 Day	/ Month	/ Year
MK2	MK2 Day	/ Month	/ Year

7. How did you allocate your time to the study?

- Spread over a long period
- In one or more intensive sessions

Please enter any comments here

8. What were the situations in which you studied? (Tick one or more)

- At work

☐ In an Army Learning Centre (ALC) or Defence e-Learing Centre (DELC)

☐ At home

Please enter any comments here

9. When did you fit in your study time?

☐ During work hours

☐ Outside work hours

☐ Some of both

Please enter comments here

10. How did you access your courses?

☐ Only (or mainly) the Internet version

☐ Only (or mainly) the CD Version

☐ Both the Internet and CD versions (roughly equally)

Please enter comments here

3. Course Design

1. How useful were the statements of study time?

○ Not useful at all

○ A little useful

○ Useful

○ Very useful

Please enter any comments

here

2. How useful were the Module Introductions?

- How useful were the Module Introductions? Not useful at all
- A little useful
- Useful
- Very useful

Please enter any comments here

3. How useful were the statements of Learning Outcomes at Module level?

- Not useful at all
- A little useful
- Useful
- Very useful

Please enter any comments here

4. How useful were the statements of Learning Outcomes at Lesson level?

- Not useful at all
- A little useful
- Useful
- Very useful

Please enter any comments

here

5. How frequently did you read through the Learning Outcomes before studying a Lesson?

Rarely

- Sometimes
- Frequently
- Always

Please enter any comments

here

6. How useful was the Knowledge Map for helping you understand the structure of the course?

- Not useful at all
- A little useful
- Useful
- Very useful

Please enter any comments

here

7. How useful was the Knowledge Map for helping you navigate through the course?

- Not useful at all
- A little useful
- Useful
- Very useful

Please enter any comments

here

8. How useful was the Lesson Map for helping you understand the structure of a lesson?

- Not useful at all
- A little useful
- Useful
- Very useful

Please enter any comments

here

9. How useful were the Lesson Maps for helping you navigate through a lesson?

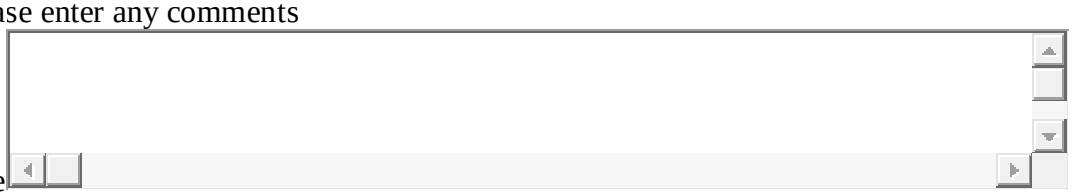
Not useful at all

A little useful

Useful

Very useful

Please enter any comments here



10. How useful was the topic navigation bar at the top of the screen?

Not useful at all

A little useful

Useful

Very useful

please enter any comments here

11. Which descriptions best fit how you navigated through the course? (Tick one or more)

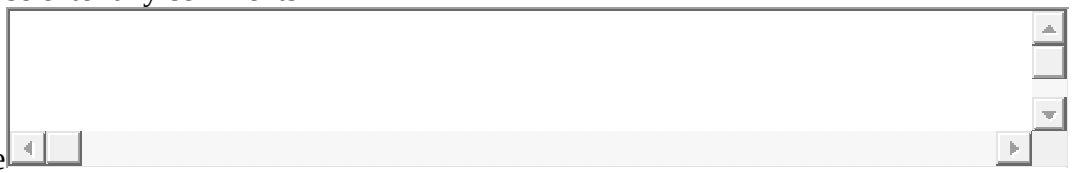
I worked through lessons in a sequential order.

I worked on lessons in which I was interested.

I first worked on lessons where I was unsure of the content.

I first worked on the lessons where I already knew something and then filled gaps in my knowledge.

Please enter any comments here



12. Which description best fits how you worked through the lessons? (Tick one or more)

I worked sequentially through the topics.

I moved between topics to check my understanding.

Please enter any comments

here

13. How useful were the following two items as aids to understanding?

	Not useful at all	A little useful	Useful	Very useful
The animated graphics	The animated graphics Not useful at all	A little useful	Useful	Very useful
The embedded hypertext items with icon 'i'	The embedded hypertext items with icon 'i' Not useful at all	A little useful	Useful	Very useful

Please enter any comments

here

14. How frequently did you use the online lesson summaries or the printed lesson summaries to check your understanding?

	Rarely	Sometimes	Frequently	Always
The online lesson summaries	The online lesson summaries Rarely	Sometimes	Frequently	Always
The printed lesson summaries	The printed lesson summaries Rarely	Sometimes	Frequently	Always

Please enter any comments

here

15. How frequently did you work through the lesson activities?

- Rarely
- Sometimes
- Frequently
- Always

Please enter any comments

here

16. How frequently did you work through the lesson assessment questions?

- Rarely
- Sometimes
- Frequently
- Always

Please enter any comments here

17. How useful were the lesson assessment questions?

- Not useful at all
- A little useful
- Useful
- Very useful

Please enter any comments here

18. How easy to follow were the module assessment procedures?

- How easy to follow were the module assessment procedures? Very difficult
- Difficult
- Easy
- Very easy

Please enter any comments here

19. How would you rate the quality of the questions in the module assessments?

- Very poor
- Poor
- Good

Very good

Please enter any comments here

4. Learning Satisfaction

1. What were the things (if any) that you liked about the course? Please comment with reference to the structure, content, navigation, assessments or other features of the courses.

2. What were the things (if any) that you disliked about the course? Please comment with reference to the structure, content, navigation, assessments or other features of the courses.

3. In what ways do you think the course could be improved?

5 Learning Performance

1. Working through the MK courses has helped me become a more efficient and effective learner.

Strongly disagree

Disagree

Agree

Strongly agree

Please enter comments here

2. I would be happy to do more studying by online distance learning.
Strongly disagree

Disagree

Agree

Strongly agree

Please enter comments here

6. Interviews?

Thank you for completing the online survey.

Would you be willing to be interviewed about your experiences of studying the MK courses? (Interviews are normally conducted by phone). If yes, please let me have your contact details. Thank you.

Yours Sincerely,

Chunyu Cong (Ms)

Your contact details

Email	
Tel No (work)	
Tel No (home)	
Mobile	

APPENDIX C: THE LETTER OF CONSENT – INTERVIEW

Project: Applying and Evaluation Approach to the Design of Resource Based Interactive Learning Environments

Researcher: Chunyu Cong, PhD Student, Cranfield University
EMAIL c.cong@cranfield.ac.uk , TEL – (0044) 01793 314402

Project Supervisor: Dr. Bernard, Scott, Head of Flexible Learning Support Centre, DCMT
EMAIL b.scott@cranfield.ac.uk, TEL – (0044) 01793 785120

You have been invited to participate in an exploratory study of the use of resource based learning (RBL) environments in formal learning. Participation is voluntary.

• The researcher will interview with you about your study experience with MK courses.

• The interview will last for 1-2 hours.

• The results of the study will be published as a PhD thesis in Cranfield University and are likely be used in educational writing and/or conference presentations as well. You can request a digital copy of the results from the researcher.

• Interview notes will be kept by the researcher in hard copy or digital form on CD storage for a period of five years and then destroyed.

Privacy, Confidentiality and Anonymity:
All information will be held confidential, except when legislation or a professional code of conduct requires that it be reported. To protect your anonymity, you will be issued a pseudonym.

Consent:
I have read and understood the information contained in this letter and I agree to participate in the study, on the understanding that I may refuse to answer certain questions, and I may withdraw during the data collection period.

Date: _____

Signature: _____

Print name: _____

APPENDIX D: INTERVIEW WITH MK STUDENTS PROTOCOL

Date:

A. About You

Name:
Rank:
Contact Details:
Unit:
Current Occupation:

1. Did you have previous experience of e-learning before you studied MK?
2. How would you read your general IT skills (PC and Internet)?
3. What course did you study: MK1, MK2...?
4. When did you complete?
5. Over what period of time did your study take place?
6. What were the situations in which you studied?
7. Did you have an internet connection when you studied MK course(s)?

B. About your experience of studying MK courses
   1. What are some of your overall impressions about the MK course(s) and the circumstances in which you studied?

C. How did you study the MK courses?
   Ask student to access the course (log in) and talk through how they studied.
   As appropriate ask about:
   1. How often did you log on?

      What was the typical study time?

      Use of VLE or CD versions?

   2. Refer to Bb course site ask for comment on menus, usefulness and navigation, use of study guide(s), FAQs, assessment policy, download of summaries

   3. How useful the statements of study time in study guide(s)?
      Not useful at all, A little useful , Useful, Very useful

   4. How did the student use the knowledge map, if at all(Bb and / or CD version)?
      Questionnaire A3:
      How useful was the knowledge map for helping you understand and structure of the course?

Not useful at all, A little useful , Useful, Very useful

Questionnaire A4:
How useful was the knowledge map for helping you navigate through the course?
Not useful at all, A little useful , Useful, Very useful

5. Ask student to demonstrate and talk through a typical study session.
   (a) Ask about use of Part, Module, Part Introduction, Section Introduction and Learning Outcomes.

   (b) At lesson level, ask about :
      (i) Learning outcomes
      QA1: It was helpful to have learning outcomes specified down at the level of individual lessons.
      Strongly disagree, Disagree, Neutral , Agree and Strongly agree

      QA2: How frequently did you read through the learning outcomes before studying a lesson?
      Rarely ,Sometimes, Frequently , Always

      (ii) Lesson map
      QA5: How useful was the lesson map for helping you understand the structure of a lesson?
      Not useful at all, A little useful, Useful , very useful

      QA6: How useful were the lesson maps for helping you navigate through a lesson?
      Not useful at all, A little useful, Useful , very useful

      How useful were the topic navigation bar?
      Not useful at all, A little useful, Useful , very useful

      (iii) Navigate through course
      QA7: Which description best fits how you navigated through the course.
      a. I worked through the lessons in a sequential order.
      b. I worked on lessons in which I was interested.
      c. I first worked on a lesson where I was unsure of the content.
      d. Other.

      (iv) Navigate through lesson

QA8: Which description best fits how you worked through the lessons

a. I worked sequentially through the topics.
b. I moved between topics to check my understanding.
c. Other

(v) How useful were the animated graphics as aids to understanding?
Not useful at all A little useful Useful Very useful

(vi) How useful were the embedded hyper text items (*i*) as aids to understanding?
Not useful at all A little useful Useful Very useful

(vii) Summaries
QA9: How frequently did you use the online lesson summaries to check your understanding?
Rarely Sometimes Frequently Always

How frequently did you use the printed lesson summaries to check your understanding?
Rarely Sometimes Frequently Always

(viii) Activities
QA10: How frequently did you work through the lesson activities?
Rarely Sometimes Frequently Always

(ix) Lesson assessment
QA11: How frequently did you work through the lesson
Rarely Sometimes Frequently Always

QA12: How useful were the lesson assessment questions?
Not useful at all A little useful Useful Very useful

6. How did you find the summative assessment requirements?
   (a) Procedures

   (b) Relevance and quality of questions

7. Learning Satisfaction

Structure, content, navigation and assessments
QBA1: What were the things (if any) that you liked about the courses?

QBA2: What were the things (if any) that you disliked about the courses?

QBA3: In what way do you think the course could be improved?

8. Learning Performance
   QBB1: Working through the MK courses has helped me become a more efficient and effective learner.
   Strongly disagree, Disagree, Neutral, Agree, Strongly agree

   QBB2: I would be happy to do more studying by online distance learning.
   Strongly disagree, Disagree, Neutral, Agree, Strongly agree

APPENDIX E: THE LETTER OF CONSENT – OBSERVATION

Project: A Principled Approach to the Design of Resource Based Interactive Learning Environments

Researcher: Chunyu Cong, PhD Student, Cranfield University
EMAIL c.cong@cranfield.ac.uk , TEL – (0044) 01793 314402

Project Supervisor: Dr. Bernard, Scott, Head of Flexible Learning Support Centre, DCMT
EMAIL b.scott@cranfield.ac.uk, TEL – (0044) 01793 785120

You have been invited to participate in an exploratory study of the use of resource based learning (RBL) environments in formal learning. Participation is voluntary.

• Over a period of several weeks, the researcher will observe how you study some multimedia interactive learning materials.

• Each learning session will last for 1-2 hours. You are asked to attend for up to six of these learning sessions.

• The results of the study will be published as a PhD thesis in Cranfield University and are likely be used in educational writing and/or conference presentations as well. You can request a digital copy of the results from the researcher.

• Observational notes will be kept by the researcher in hard copy or digital form on CD storage for a period of five years and then destroyed.

Privacy, Confidentiality and Anonymity:
All information will be held confidential, except when legislation or a professional code of conduct requires that it be reported. To protect your anonymity, you will be issued a pseudonym.

Consent:
I have read and understood the information contained in this letter and I agree to participate in the study, on the understanding that I may refuse to answer certain questions, and I may withdraw during the data collection period.

Date: _____

Signature: _____

Print name: _____

Instructions:

You are asked to study a course called *Military Knowledge 1*. The course consists of a set of standalone interactive multimedia learning materials, delivered by CDROM.

We are interested in how you choose to work through the learning materials. The researcher will observe what you do and will also ask you to explain why you are choosing to do what you do.

The course consists of a set of 6 Modules. Each module is divided into Sections and each Section contains one or more Lessons. We have selected some parts of the course for you to study.

The parts are:

Module1, Section1, Lesson1
Module2, Section1, Lessons1-3
Module2, Section2, Lessons1-2
Module4, Section1, Lesson1

The titles of the parts selected are shown in the Table below.

Module1 : The British Army Section1: The Arms and Services Lesson1: The Structure of the British Army
Module2: The British Approach to Operations Section1: Physical and Moral Components Lesson1: The Nature of Conflict and Military Effectiveness Lesson2: Military Effectiveness Lesson3: The Conceptual Component of Fighting Power Section2: The Conduct of Operations Lesson1: The Manoeuvrist Approach to Operations Lesson2: The Core Functions and the Operational Framework
Module4: Battlegroup Science & Technology Section1: Basic Science Lesson1: The Principles of Matter

You are free to study the lessons in any order you wish.

Please refer to the MK1 study guide for more information about the course. Please work through the MK1 Interactive Study Guide which provides advice on to how work through the interactive multimedia lesson content. The researcher will help ensure you fully understand all the features and options to be found in the learning materials.

At the end of your study period, the research will interview you to find out what you think about how the learning materials have been designed. There will also be a short test to assess how effective your learning has been.

Any questions?

APPENDIX F: MK1 SUMMATIVE ASSESSMENT TEST

1. Introduction

Dear Student,

Thank for visiting the MK1 summative assessment site.
The aim of this assessment is to find out about your learning experiences of MK1.
It will take you approximately forty minutes to complete the assessment.
Individuals will not be identified in the analysis and presentation of the data.
If you have any queries, please do not hesitate to contact me by email at c.cong@cranfield.co.uk

Thank you for your participation.

Best regards,

Ms Chunyu Cong,

Researcher,

Flexible Learning Support Centre,

DCMT

Assessment
1. The regimental system is "a mechanism whereby human behaviour can be controlled and directed to fulfil operational requirements".
Army Policy and Resources Committee

- True
- False

2. If you were deployed on Operations working to a brigade HQ, which organisation would you work to?

- The Operational Organisation
- The Administrative Organisation
- The Functional Organisation

3. Which of the following are parts of the main organisational structure of the Army? (Multiple response question)

- The Functional Organisation
- The Administrative Organisation
- The Operational Organisation

- [ ] The Regimental System
- [ ] The Divisional System

4. If you were involved in the training of recruits for your Arm or Service, which organisational chain would you work to?
The Operational Organisation

- [ ] The Functional Organisation
- [ ] The Administrative Organisation

5. Below brigade level warfighting operations will normally be conducted by task-oriented, all-arms groupings.
Which ONE of the following are these groupings commonly known as?

- ( ) Task Forces
- ( ) Coalition Forces
- ( ) Battlegroups
- ( ) Sub-units

6. Which of the following is an appropriate level of war for the operational level?

- ( ) Battles and engagements within major operations
- ( ) Joint campaigns and major operations
- ( ) Employing armed forces to achieve political objectives
- ( ) Coordinated use of economic, diplomatic and military means

7. Whose responsibility is Grand Strategy?

- ( ) Secretary of State for Defence
- ( ) Joint Chiefs of Staff
- ( ) Joint Commander
- ( ) Parliament
- ( ) Prime Minister and the Cabinet

8. Which three military activities are appropriate to conflict in the spectrum of conflict?

- [ ] Military Advice to the Government
- [ ] Counter Insurgency (COIN)
- [ ] Military Aid to the Civil Authority (MACA)
- [ ] Peace Support Operations (PSO)
- [ ] Training Teams and Military Assistance Overseas
- [ ] o Non-combatant Evacuation Operations (NEO)

- [ ] o Regional Conflict

9. Which TWO military activities are appropriate to war in the spectrum of conflict?

- [ ] Public Duties
- [ ] Regional Conflict
- [ ] Training for War and Other Operations
- [ ] Military Security
- [ ] General War

10. Intensity refers to the degree and frequency of violence encountered in conflict.

- ( ) True
- ( ) False

11. Military effectiveness can be measured against the absolute standards set out in collective performance procedure.

- ( ) True
- ( ) False

12. Which of the following are components of fighting power? (Multiple response question)

- [ ] Perceptual Component
- [ ] Physical Component
- [ ] Conceptual Component
- [ ] Moral Component

13. Which of the listed Principles of War is the master principle?

- ( ) Selection and maintenance of the aim
- ( ) Maintenance of morale
- ( ) Offensive action

14. Which of the following statements best summarises concentration of force?

- ( ) ability to deliver the desired effect when and where required
- ( ) amassing all your forces together
- ( ) both of the above

15. Protection should be total.

- ( ) True

- False

16. Which is the best definition of the manoeuvrist approach to operations?

- The ability to move faster than an enemy and detain, or defeat him.
- The ability to prepare and defend a position of advantage to detain or defeat an enemy force.
- The ability to seek a position of advantage from which force can be threatened or applied.
- The ability to locate and engage a highly mobile enemy and defeat him.

17. Which is the best description of attacking the will of the enemy?

- Attacking his ability to control his actions.
- Attacking his ability to resist attacks on his will.

18. What is the term used to describe overloading the enemy commander with a multitude of concurrent threats?

- Surprise
- Simultaneity
- Shock
- Synchronisation

19. What form of warfare is often contrasted with the manoeuvrist approach?

- blitzkrieg
- attrition
- guerrilla
- asymmetric

20. In attacking the enemy's will the commander should strive to frustrate the enemy's intentions at every stage.

- True
- False

21. The core function 'exploit' depends on which three principles of war?

- [ ] Flexibility
- [ ] Concentration of force
- [ ] Cooperation
- [ ] Sustainability

- [ ] Maintenance of morale
- [ ] Surprise
- [ ] Economy of effort
- [ ] Security
- [ ] Offensive action
- [ ] Selection and maintenance of the aim

22. The core functions operate in a cycle, therefore a commander will always 'strike' an enemy after he has 'fixed' him.

- True
- False

23. What is the aim of the strike core function?

- To defeat the enemy in accordance with the main aim of the mission.
- To deny the enemy room to manoeuvre.
- To inflict as much damage as possible on the enemy in as short as time as possible.
- To reduce the enemy's ability to attack you.

24. Effective rear operations are not essential for successful deep and close operations.

- True
- False

25. The core functions of find, fix, strike and exploit can only be carried out sequentially.

- The core functions of find, fix, strike and exploit can only be carried out sequentially. True
- False

26. Whilst atoms can be found as individual entities, it is more common to find them combined with other atoms to form larger entities.
What are these entities called?

- Particles
- Molecules
- Ions
- Sub atoms

27. Lightning is produced when large charges of static electricity in the atmosphere Earth discharge themselves violently.

True

False

28. Nuclear-powered submarines have nuclear reactors which carry out nuclear fission under controlled conditions.

True

False

29. Atoms with unstable nuclei emit some of their energy as radiation.

True

False

30. A nuclear explosion has five principal effects these include blast, light and electromagnetic pulse. What are the other two main effects?
Write your answers in the spaces provided.

1

2

3. About You

Thank you very much for completing the online assessment.

Please enter your contact details below.
1. Your contact details

Name

Email

Tel No (work)

Tel No (home)

Mobile

APPENDIX G: ONLINE MASTER PROGRAMME SURVEY

1. Introduction

Dear Student,

Thank for visiting the online courses survey site.

The aim of this questionnaire is to find out about your experiences of online learning using the Moodle virtual learning enviroment (VLE).

We are particularly interested in your views about how the course was designed and presented.We will not ask you about the content of the course.

It will take you approximately ten minutes to complete the questionnaire.

Please be assured your response will be strictly confidential. Individuals will not be identified in the analysis and presentation of the data.

If you have any queries, please do not hesitate to contact me by email at flhelp.cu@defenceacademy.mod.uk

Thank you for your participation.

Best regards,

Dr Bernard Scott,

Flexible Learning Support Centre,

DCMT

2. About Your Module

1. What is the name of your course?

2. What is the name of the module you have been studying?

3. What type of course are you studying?

- ☐ Full-tme residential course
- ☐ Part-time/executive course
- ☐ Distance learning course
- ☐ Short Course

3. About Your Experiences of Online Learning

1. Do you have other experiences of online learning?

- ☐ Online training package
- ☐ Online degree courses
- ☐ Open University

Please enter any comments here 

2. How would you rate your general IT Skills (PC and Internet)?

- ○ Very Poor
- ○ Poor
- ○ Good
- ○ Very Good

Please enter any comments here 

4. About Your Use of the DCMT VLE

1. Were you given training in the use of the VLE?

- ☐ Yes, face-to-face
- ☐ Yes, online
- ☐ No

Please enter comments here 

2. How did you allocate the time to your studies?

- ☐ Regular intervals
- ☐ Intensive sessions

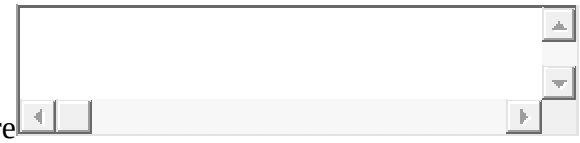
Please enter comments here 

3. What were the situations in which you studied? (Tick one or more)

- ☐ At work

☐ In an Army Learning Centre (ALC) or Defence e-learning Centre (DELC)

☐ At home

Please enter comments here 

4. When did you fit in your study time?

○ During work hours

○ Outside work hours

○ Some of both

Please enter comments here 

5. About Technical Issues

1. What access do you have to computer equipment to use the VLE?

○ Daily access

○ Fairly regular access

○ Infrequent or inadequate access

Please enter comments here 

2. What type of Internet access do you have?

○ Broadband

○ Dial-up connection

Please enter comments here

3. Was the download time acceptable?

○ Yes

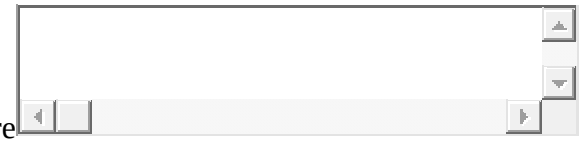
○ No

Please enter comments here 

4. Did you find the level of technical support appropriate?

○ Yes

- No
- N/A

Please enter comments here 

6. About the Module

1. Did you find it easy to navigate to the different areas of the module?

- Yes
- NO
- N/A

Please enter comments here 

2. Was the text easy to read online?

- Yes
- No
- N/A

Please enter comments here 

3. Did links work with no problems?

- Yes
- NO
- N/A

Please enter comments here 

4. Did the module contain a clear indication of aims and learning outcomes?

- Yes
- No
- N/A

Please enter comments here

5. Were you given an indication of study times within the module?

- Yes, module timetable
- Yes, for specific elements of the module
- Yes, for directed reading
- NO

Please enter comments here

6. How useful were the statements of study time (if any) with the module?

- Not useful at all
- A little useful
- Useful
- Very useful

Please enter any comments here

7. How useful was the module study guide and/or other introductory information?

- Not useful at all
- A little useful
- Useful
- Very useful

Please enter any comments here

8. How useful were the statements of Learning Outcomes?

- Not useful at all
- A little useful
- Useful

Very useful

Please enter any comments here

9. How frequently did you read through the Learning Outcomes?

Rarely

Sometimes

Frequently

Always

Please enter any comments here

10. How useful was the Site Map for helping you understand the structure of the module?

Not useful at all

A little useful

Useful

Very useful

Please enter any comments here

11. How useful was the Site Map for helping you navigate through the module?

Not useful at all

A little useful

Useful

Very useful

Please enter any comments here

12. Which descriptions best fit how you navigated through the module? (Tick one or more)

- ☐ I worked through units/lessons in a sequential order.
- ☐ I worked on units/lessons in which I was interested.
- ☐ I first worked on the units/lessons where I was unsure of the content.
- ☐ I first worked on the units/lessons where I already knew something and then filled gaps in my knowledge.

Please enter any comments here

13. Did the module use activities or self-assessment questions to support learning?

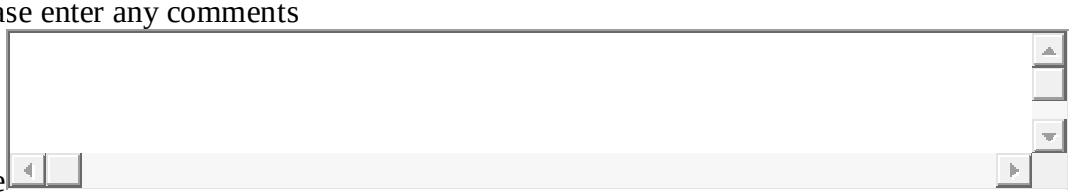
- ○ Yes
- ○ No
- ○ N/A

Please enter comments here

14. If applicable, how frequently did you work through the activities/self-assessment questions?

- ○ Rarely
- ○ Sometimes
- ○ Frequently
- ○ Always

Please enter any comments here



15. If applicable, how useful were the activities/self-assessment questions?

- ○ Not useful at all
- ○ A little useful
- ○ Useful
- ○ Very useful

Please enter any comments

here

16. Did you receive feedback on how you could improve your learning?

- ☐ Yes, instant feedback
- ☐ Yes, tutor feedback
- ☐ No

Please enter comments here

17. Were different media used appropriately and effectively?

- ○ Yes
- ○ No
- ○ N/A

Please enter comments here

18. Were resources clearly referenced?

- ○ Yes
- ○ No
- ○ N/A

Please enter comments here

19. If you used discussion forums in your module:

- ☐ They were used effectively
- ☐ They had clear instructions
- ☐ I did not use discussion forums

Please enter comments here

20. If you used social networking applications (eg wikis and blogs) in your module:

- ☐ They were used appropriately and effectively.
- ☐ I did not use social networking applications.

Please enter comments here

21. Did you submit assignment (s) electronically?

- Yes, using Turnitin
- Yes, using another submission method
- No
- N/A

Please enter comments here

22. Did you get training on assignment submission?

- Yes
- No
- N/A

Please enter comments here

23. How easy to follow were the summative assessment procedures?

- Very difficult
- Difficult
- Easy
- Very easy

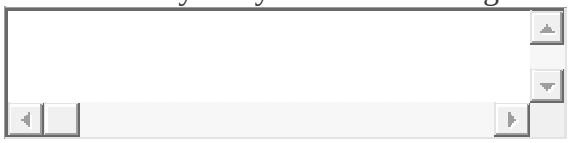
Please enter any comments here

7. General Overview

1. What were the things (if any) that you liked about the module? Please comment with reference to the structure, navigation, assessments or other features of the courses were designed.

2. What were the things (if any) that you disliked about the module? Please comment with reference to the structure, navigation, assessments or other features of the courses were designed.

3. In what ways do you think the design of the module could be improved?



4. Working through the module has helped me become a more efficient and effective learner.

- Strongly disagree
- Disagree
- Agree
- Strongly agree

Please enter comments here

5. I would be happy to do more studying by online distance learning.

- Strongly disagree
- Disagree
- Agree
- Strongly agree

Please enter comments here

8. About You (Optional)

Thank you very much for completing the online survey. Your responses will help us improve the quality of online learning at DCMT.

Are you willing to be interviewed by telephone about your experience of studying online? If yes, please enter your contact details below.

1. Your contact details

Your contact details Email	
Tel No (work)	
Tel No (home)	
Mobile	

APPENDIX H: E-LEARNING AUTHORING TOOLS

Name	Free	Latest Version Date	Address	Features			
				Creating Content	Quiz	Interactivity	SCORM
1.Articulate Rapid E-learning Studio	No	April 2006	http://www.articulate.com/products/studio.php	*	*	*	
2.Epistudio	No	March 2007	http://www.epistema.com/en/page.php?rubrique=pages_solutions_en&page=10	*	*	*	*
3.Authorware	No	June 2003	http://www.epistema.com/en/page.php?rubrique=pages_solutions_en&page=10	*	*	*	
4.Canvas Learning	No	January 2005	http://www.canvaslearning.com/	*	*	*	
5.Compendle Professional	No	May 2007	http://www.customcourse.com/	*	*	*	*
6.Composica Enterprise	No	October 2005	http://www.composica.com/	*	*	*	*
7.Construct Author	No	August 2004		*	*		*
8.Content Point	No	September 2004	http://www.atlantic-link.co.uk/contentpoint.htm	*	*	*	
9.CopyCat Studio	No	April 2004	http://copycatsoftware.jsn-server3.com/	*	*	*	
10.CourseAvenue	No	June 2007	http://copycatsoftware.jsn-server3.com/	*	*		*

11.Couse Builder for Dreamweaver Extension	No	November 2005	http://copycatsoftware.jsn-server3.com/		*	*	AICC
12.course Genie	No	September 2003	http://www.wimba.com/	*	*	*	1.2
13.Dazzler	No	April 2001	http://www.dazzlersoft.com/visitors_index.htm	*			
14.Design-a-Course	No	December 2002	http://www.dazzlersoft.com/visitors_index.htm	*	*	*	
15.Dynamic PowerTrainer®	No	November 2005	http://www.dynamicpowertrainer.com/english/01_ueberblick/00_start.php	*	*		
16.EasyProf®	No	April 2007	http://www.easyprof.com/demos/pral.jsp	*	*		
17.Easyquizz®	No	March 2007			*		*
18.Elicitus Lite	No	February 2007	http://www.elicitus.com/default.htm	*		*	
19.Epistudio	No	June 2005	http://www.epistema.com/en/	*	*	*	AICC/SCORM
20.Evolution	No	May 2003	http://www.outstart.com/	*			
21.Expert Author	No	May 2003	http://www.knowledgequest.com/	*			
22.Express Train	No	March 2003	http://www.tutora.com/	*	*	*	
23.FlashForm	No	January 2007	http://www.rapidintake.com/index.htm	*	*	*	
24.Inmarkets	No	July 2006	http://www.inmarkets.com/	*	*	*	*
25.InSite	No	November	http://thorax.	*	*	*	*

Studio		2006	erc.msstate.edu/insite/default.aspx				
26.KnowledgePresenter	No	October 2005	http://www.knowledgepresenter.com/	*	*	*	*
27.Magic Box	No	April 2004	http://www.composica.com/	*	*	*	
28.Myudutu	Yes	May 2007	http://www.udutu.com/	*	*	*	
29.Rapid E-learning Suite	No	January 2007	http://www.sameshow.com/quiz-creator/powerpoint2flash-quizcreator.html	*	*	*	*
30.Rapid eL	No	January 2007	http://www.rapidel.com/	*	*	*	
31.Seminar Author	No	June 2005	http://www.seminar.co.uk/#	*	*	*	*
32.Sensa	Yes	January 2005	http://www.sensalearning.com/index.cfm	*	*	*	
33.SNAP!™ Studio	No	October 2004	http://www.percepsys.com/coursegen.htm#	*	*	*	
34.Storyboarder Pro	No	March 2007	http://www.storyboarderpro.com/downloads/	*			
35.Syber Works Web Author	No	March 2004	http://www.syberworks.com/product_sa.htm	*			*
36.Thinking Cap™	No	November 2004	http://www.thinkingcap.info/Pages/Common/ContentPage.aspx?src=default.xml	*			*
37.ToolBook	No	January 2005	http://www.toolbook.com/l	*	*	*	

Assistant			earn_assistant.php?from=menu				
38.Websoft CourseLab 2.3	Yes	August 2007	http://www.courselab.com/db/cle/root_id/wn23/doc.html	*	*	*	*
39.XplanaWorkbook	No	January 2005	http://www.xplana.com/products/products_xwb.php	*		*	

APPENDIX I: ADAPTIVE TEACHING SURVEY

1. Instruction

Dear Student,

Thank you very much for studying this lesson.

The aim of this questionnaire is to find out about your experience of learning this lesson.

It will take your approximately ten minutes to complete the questionnaire.

Please be assured your response will be strictly confidential. Individuals will not be identified in the analysis and presentation of the data.

If you have any queries, please do not hesitate to contact me by email at c.cong@cranfield.ac.uk

Thank you for your participation.

Best regards,

Ms Chunyu Cong,

Researcher,

Flexible Learning Support Centre,

DCMT

2. The acceptability of ISTAR learning material

1. How effective was the couse in helping you learn about ISTAR?

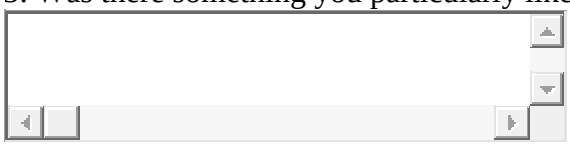
- Very much
- Moderately
- Somewhat
- Not at all

2. How enjoyable was your learning experience?

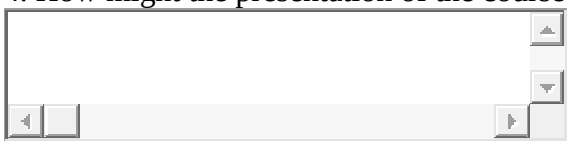
- Very much
- Moderately
- Somewhat

- Not at all

3. Was there something you particularly liked about how the course was presented?



4. How might the presentation of the course be improved?



5. How helpful were the learning tasks helping learn about ISTAR?

- Very much
- Moderately
- Somewhat
- Not at all

6. How easy was it to follow the instructions for working through the taskes?

- Very much
- Moderately
- Somewhat
- Not at all

7. I enjoyed being allowed to study at my own pace.

- Extremely Disagree
- disagree
- Neutral
- Agree
- Extremely Agree

8. I like to use this kind of design of learning material.

- Extremely Disagree
- disagree
- Neutral
- Agree
- Extremely Agree

9. I would like to use similar design of learning material , if there are chances to do e-learning courses in the future.

- Extremely Disagree
- disagree
- Neutral
- Agree
- Extremely Agree

10. How frequently did provide access to the learning tasks?

- Rarely
- Sometimes
- Frequently
- Always

APPENDIX J: LESSON MAP SURVEY

1. Instruction

Dear Student,

Thank you very much for studying this lesson.

The aim of this questionnaire is to find out about your experience of learning this lesson.

It will take your approximately ten minutes to complete the questionnaire.

Please be assured your response will be strictly confidential. Individuals will not be identified in the analysis and presentation of the data.

If you have any queries, please do not hesitate to contact me by email at c.cong@cranfield.ac.uk

Thank you for your participation.

Best regards,

Ms Chunyu Cong,

Researcher,

Flexible Learning Support Centre,

DCMT

2. The acceptability of ISTAR learning material

1. How effective was the couse in helping you learn about ISTAR?

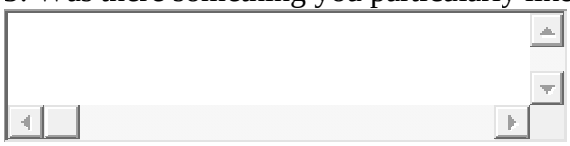
- Very much
- Moderately
- Somewhat
- Not at all

2. How enjoyable was your learning experience?

- Very much
- Moderately
- Somewhat

Not at all

3. Was there something you particularly liked about how the course was presented?



4. How might the presentation of the course be improved?

5. How helpful were the learning tasks helping learn about ISTAR?

Very much

Moderately

Somewhat

Not at all

6. How easy was it to follow the instructions for working through the taskes?

Very much

Moderately

Somewhat

Not at all

7. I enjoyed being allowed to study at my own pace.

Extremely Disagree

disagree

Neutral

Agree

Extremely Agree

8. I like to use this kind of design of learning material.

Extremely Disagree

disagree

Neutral

Agree

Extremely Agree

9. I would like to use similar design of learning material , if there are chances to do e-learning courses in the future.

- Extremely Disagree
- disagree
- Neutral
- Agree
- Extremely Agree

10. How useful was it to have the Lesson Map as a way of navigate through the course?

- Not useful at all
- A little useful
- Useful
- Very useful

PUBLISHED PAPERS

Scott, B. and Cong, C. (forthcoming). "Evaluations of course design principles for multimedia learning." *To proceed in the Defence Academies & Colleges International e-learning Conference.*

Scott, B. and Cong, C. (forthcoming). "Knowledge and task analysis methods for course design." To appear in the *University College of Fraser Valley Research Review*.

Cong, C. and Scott, B. (2008). "Learning with interactive multimedia: A case study". In K. Fernstrom, ed. *Proceedings of the International Conference on Information Communications Technologies in Education 2008, 10-12 July, Corfu.* Abbotsford, BC: UCFV Press.

Scott, B. and Cong, C. (2008). "Analysing and representing 'conversational domains'" *Proceedings of the 19th European Meeting on Cybernetics and Systems Research*, University of Vienna, March 25th-28th, 2008, pp. 132-137.

Scott, B. and Cong, C. (2007). "Knowledge and task analysis methods for course design". In K. Fernstrom, ed. *Readings in Technology in Education: Proceedings of the International Conference on Information Communications Technologies in Education 2007, 12-14 July 2007 Heraklion, Crete.* Abbotsford, BC: UCFV Press.

Scott, B., Shurville, S., MacLean, P., and Cong, C. (2007). "Cybernetic Principles for Learning Design". *Kybernetes*, 36(9/10), pp. 1497-1514.

Scott, B. and Cong, C. (2006). "Designing interactive learning environments: an approach from first principles". *Campus-Wide Information Systems*, 24, 3, pp. 174-186.

Scott, B. and Cong, C. (2006). "Designing interactive learning environments: an approach from first principles". In K. Fernstrom and K. Tsolakidis, eds. *Readings in Technology in Education: Proceedings of the International Conference on Information Communications Technologies in Education 2006,* 6-8 July 2006 Rhodes. Abbotsford, BC: UCFV Press.